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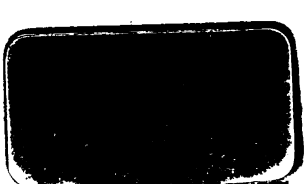

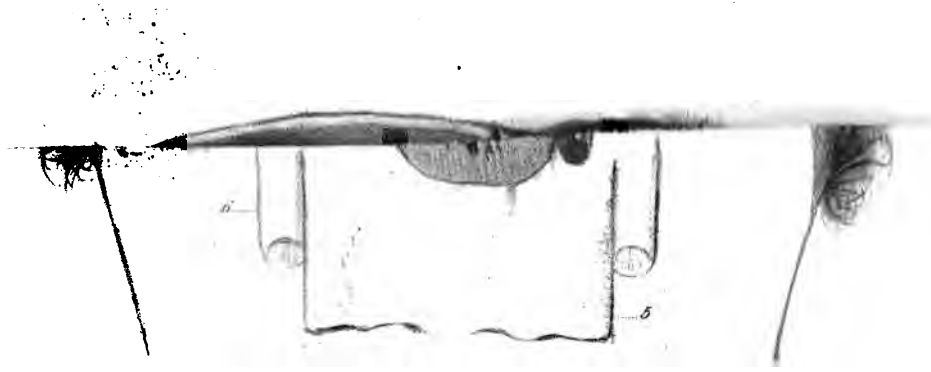


*For Explanation See P. 239.*

*Drawn on Stone by*
A.N.RINTOUL.

*From a dissection by*
DOCTOR VALENTINE FLOOD.

*J.Graf, Printer to Her Majesty.*

THE

# SURGICAL ANATOMY

OF

# THE ARTERIES,

AND

# DESCRIPTIVE ANATOMY

OF

# THE HEART:

TOGETHER WITH

## THE PHYSIOLOGY OF THE CIRCULATION

IN

MAN AND INFERIOR ANIMALS.

BY

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NORTH LONDON SCHOOL OF MEDICINE.

——— si quid novisti rectius istis,
Candidus imperti; si non, his utere mecum.

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# PREFACE.

My principal object in writing the following pages, has been to present the professional reader with an accurate description of the Heart and Arteries of the human subject, in as condensed a form as would be consistent with clearness. To make the work still farther available for practical purposes, I have added a description of the principal operations performed on the larger trunks, and incorporated a vast number of the varieties, which an operating surgeon should be prepared to meet in the course of his practice. In collecting the anomalies of the vascular system, I have freely availed myself of the labours of Farre, Baillie, Meckel, Haller, Barkow, Bouillaud, Otto, Gintrac, Burns, Barclay, Tiedeman, Geddings, Cruveilhier, Wardrop, and the authors of various articles, in the *Philosophical Transactions*, *Cyclopædia of Anatomy*, and periodical works of the present and several preceding years. I have also to express my special obligation to Dr. P. H. Green, who, since my settlement in London, has liberally permitted me to peruse his scarce and valuable work on the varieties of the arteries — a

work of the deepest research, and abounding in the most accurate information. The nature of the present undertaking would not allow me to give more than a mere sketch (see Appendix) of the important operations of Brasdor and Wardrop. But this is of less consequence, as the latter highly talented gentleman has given a very ample report of them in the article *Aneurism*, in the *Cyclopædia of Surgery*.

In the form of an introduction will be found an outline of the physiology of the circulating system, in man and inferior animals, illustrated by several wood-cuts.

Had I merely the rapid sale of this work in view, I would have brought it out at the beginning of the medical session, in the form advertised—in which form it was then perfectly ready. But I have kept it back, at much trouble and expense to myself, and added considerably to its usefulness, without any increase whatever in its price.

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# INTRODUCTION.

## CIRCULATION OF THE BLOOD.

The distribution of the nutritive fluid in the animal economy serves for three important purposes: — 1. For the support of the frame; 2. For conveying materials for the various secretions and excretions; and 3. For subjecting the nutritive fluids to the influence of oxygen gas. For these purposes, we find a system of vessels specially set apart, and, in the greater number of cases, one or more propulsive cavities termed *hearts.*

In the whole class of vertebrated animals (if we except an occasional accessory dilatation, as the caudal heart of the eel), we find but one heart, from which the blood sets out, and to which, having moved through the vessels in a circuit, it returns; hence the term *circulation* of the blood. This heart may either consist of two chambers, as in the fish; of three, as in reptiles; of four, as in birds and man; or of five, as in the *Crocodilus Nilus.*

Amongst the invertebrate animals, we find that in some instances there is but one heart, consisting either of a ventricle only, as in the lobster, or of an auricle and a ventricle, as in the garden snail. In other instances, the heart exists in an elongated form. Of this we have an instance in the dorsal pulsating vessel of the earth-worm, which physiologists consider a true heart, inasmuch as it performs the functions of one. It is in this form that the human heart exists in the early periods of intra-uterine life; and if the development of the heart be arrested, we have then what is termed an acardiac fœtus. In many other invertebrate animals the hearts are multiplied; thus in the cuttle fish there are three. In all the above cases there is a system of vessels, and a true circulation.

As we descend still lower in the scale, we find a vascular system, without any discernible heart; and lastly, in many of the zoophytes, which form the lowest grade, no vascular system can be

detected, and the fluids prepared in the stomach of the animal appear to simply transude through its substance, to be deposited for its support. As our means of observation have increased, the list of animals thus circumstanced has diminished; and recent discoveries of a circulation in microscopic animals lead to the conclusion that vessels exist in many cases, in which they have not been hitherto detected.

In the farther elucidation of this subject I shall have occasion to refer constantly to Cuvier's classification of the animal kingdom (which I accordingly subjoin); and, beginning at the bottom of the scale, take a rapid survey of the distribution of the nutritive fluids in each class. We find, by reference to the table, that Cuvier divides the animal kingdom into four great classes, viz. *Vertebrata*, *Mollusca*, *Articulata*, and *Zoophyta*.*

OUTLINE OF CUVIER'S CLASSIFICATION OF ANIMALS; WITH EXAMPLES OF SPECIES BELONGING TO EACH DIVISION.

## I. Vertebrata.

### 1. *Mammalia.*

*Bimana*, man.
*Quadrumana*, monkey, ape, lemur.
*Cheiroptera*, bat, colugo.
*Insectivora*, hedge-hog, shrew, mole.
*Plantigrada*, bear, badger, glutton.
*Digitigrada*, dog, lion, cat, martin, weasel, otter.
*Amphibia*, seal, walrus.
*Marsupialia*, opossum, kangaroo.
*Rodentia*, beaver, rat, squirrel, porcupine, horse.
*Edentata*, sloth, armadillo, ant-eater, pangolin.
*Pachydermata*, elephant, hog, rhinoceros, tapir, horse.
*Ruminantia*, camel, musk, deer, giraffe, antelope, goat, sheep, ox.
*Cetacea*, dolphin, whale.

---

* It would be more logical to divide the animal kingdom into Vertebrata and Invertebrata, and then subdivide the latter into Mollusca, Articulata, and Zoophyta.

2. *Aves.*

*Accipitres*, vulture, eagle, owl.
*Passeres*, thrush, swallow, lark, crow, sparrow, wren.
*Scansores*, woodpecker, cuckoo, toucan, parrot.
*Gallinæ*, peacock, pheasant, grouse, pigeon.
*Grallæ*, plover, stork, snipe, ibis, flamingo.
*Palmipedes*, auk, grebe, gull, pelican, swan, duck.

3. *Reptilia.*

*Chelonia*, tortoise, turtle.
*Sauria*, crocodile, lizard, chamelion.
*Ophidia*, serpents, boa, viper.
*Batrachia*, frog, salamander, proteus, siren.

4. *Pisces.*

*Chondropterygii*, lamprey, shark, ray, sturgeon.
*Plectognathi*, sun-fish, trunk-fish.
*Lophobranchi*, pipe-fish, pegasus.
*Malacopterygii*, salmon, herring, pike, carp, silurus, cod, sole remora, eel.
*Acanthopterygii*, perch, mackerel, sword-fish.

II. Mollusca.

*Cephalopoda*, sepia, nautilus.
*Pteropoda*, clio, hyalæa.
*Gasteropoda*, slug, snail, limpet.
*Acephala*, oyster, muscle, ascidia, pyrosoma.
*Brachiopoda*, lingula, terebratula.
*Cirrhopoda*, barnacle.

III. Articulata.

1. *Annelides*, or *Vermes.*

*Tubicolæ*, serpula, sabella.
*Dorsibranchiæ*, nereis, aphrodite.
*Abranchiæ*, earth-worm, leech.

2. *Crustacea.*

*Decapoda*, crab, lobster, prawn.
*Stomapoda*; squill.
*Amphipoda*, grammarus.
*Isopoda*, asellus.
*Branchiopoda*, monoculus.

3. *Arachnida.*

*Pulmonalia*, spider, scorpion.
*Trachealia*, phalangium, mite.

4. *Insecta.*

*Aptera*, centipede, podura.
*Coleoptera*, beetle, glow-worm.
*Orthoptera*, grasshopper, locust.
*Hemiptera*, fire-fly, aphis.
*Neuroptera*, dragon-fly, ephemera.
*Hymenoptera*, bee, wasp, ant.
*Lepidoptera*, butterfly, moth.
*Rhipiptera*, xenos, stylops.
*Diptera*, gnat, house-fly.

IV. Zoophyta.

*Echinodermata*, star-fish, echinus.
*Entozoa*, fiuke, tænia, hydatid.
*Acalephæ*, actinia, medusa.
*Polypi*, hydra, coralline, pennatula, sponge.
*Infusoria*, brachionus, vibrio, proteus, monas.

---

## ZOOPHYTA.

*Infusoria.* — Ehrenberg has described a kind of circulation in some of the Infusoria; but Dr. Thomson is disposed to doubt the accuracy of his observations, on account of the prevalence of various kinds of ciliary currents in the interior of many of these animals.

*Polypi.* — Mr. Lister has observed in each of the divisions of the stem of the tubularia indivisa a current of fluids, bearing globules, proceeding up one side and down the other. These currents have a striking analogy to those occurring in the stem of some plants, as the Chara and Caulinia.

*Acalephæ* * have in general no appearance of a vascular system. Eschscholtz, however, has described a circulating apparatus in the Beroe and Cestum. In the former, vessels have been described as arising from the sides of the digestive canals, which absorb its fluids and convey them to the ciliated processes to be oxygenised. In the latter animal, which has a riband-like form, and is sometimes upwards of five feet long, the alimentary canal crosses the body, and around its outlet is a circle of vessels, the branches of which are distributed through its whole length, and particularly in the ciliary margins, where oxygenisation of the nutritive fluid appears to take place.

*Entozoa.* — Organs of circulation have been observed in animals inhabiting the aqueous humor of the eyes of some quadrupeds. In the limbs of the Diplogoon currents may be seen moving in opposite directions in two distinct sets of vessels. Dugès has detected in the Planaria three longitudinal vessels; one in the dorsal region on the middle line, and one on each side. These communicate with each other, and are seen to contract and dilate.

*Echinodermata* † possess the most highly developed vascular system of all the zoophytes. Thus *in the Holothuriæ* there is an elongated heart, which communicates with a vascular ring, surrounding the alimentary canal. From this ring arteries proceed to the gills, and the returning veins transmit their contents through a single trunk to the heart.

---

* These animals are all inhabitants of the sea, and derive their name from the Greek word ακαλη$\phi$η, a nettle, on account of the property that several of them possess of irritating the surface of the skin.

† From ε$\chi$ινος echinus, and δερμα corium. They receive their name from their surface being generally covered with prickles. Some, however, that have not the surface in this state (as the Holothuria) are nevertheless classed with them, on account of their correspondence as to internal structure. They are all inhabitants of the sea.

In the *Asteria* the stomach sends processes into the rays, and on the surface of each process lies a vessel, which absorbs from its cœcal appendices: these vessels proceed to the centre, and, after uniting with other vessels from the stomach, form a vascular ring or circle at the upper part of the body. This circle communicates with another that is situated at the lower part of the body and surrounds the mouth. The communication is effected by a vertical descending vessel, which has been considered as a heart: the vessels surrounding the mouth send branches over the system generally. No communication however has been yet discovered between these branches and those terminating in the upper circle; and therefore we are unable to pronounce on the existence of a true circulation in these animals.

In the *Echinus*, the vessels arising from the sides of the alimentary canal unite into a single trunk, which afterwards subdivides into several branches that ramify on a serous membrane analogous to the peritoneum *, which lines the cavity that contains the viscera. The water being admitted into this cavity, the blood is aërated, and then passes through a series of vessels to a circle which surrounds the outlet of the alimentary canal: from this it is conveyed to the opposite extremity of the intestine, where it enters a small oval canal, which is the heart. From the heart arise the arterial branches, which are distributed to the muscles and dental apparatus, and then, proceeding along the intestines, are continuous with the vessels first described. Here therefore is a distinct circulation.

## ARTICULATA.

It is not intended by this term to convey that all the animals so denominated possess articulated limbs, but merely that they have an articulated or jointed body, consisting of several distinct rings or segments. This is extremely evident in the leech and other Annelida; but it is equally true of all the Articulata, though in some, as the crab, it is not at first so obvious.

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* There is something analogous to this in the crocodile, the peritoneum of which is pierced by two openings.

Amongst the Articulata we find that the

*Crustacea* (as the lobster and crab) possess a system of arteries and veins. Their blood is propelled by a ventricle, situated in the dorsal region, and they respire by gills. In the Squillæ the heart is elongated and tubular.

The *Annelida* (as the leech and earth-worm) have an elongated form, and appear composed of a series of rings. They possess a system of arteries and veins, and the vessels are often interrupted by several propulsive cavities or hearts. The colour of their blood is in most cases *red*, and they respire by branchiæ, but in some instances by internal sacs.

In the Lumbricus, or Earth-worm, there are two principal vessels, an upper and a lower, both situated on the middle line: the upper one, being the more contractile, is considered as the heart: it conveys the blood from behind forwards, and the inferior vessel returns it from before backwards. These vessels are connected by numerous small cross branches, and by five to eight larger ones on each side, which are of a semicircular form, and remarkable for presenting certain dilatations. The first of these dilatations is on the dorsal surface; it is larger than the rest, and of an oval elongated form, and the others are more spherical and give it the appearance of a row of beds. There is also a dilatation in the abdominal vessel, where the transverse one joins it; the dilatations are supposed to aid in propelling the blood. There are also in this animal three other longitudinal vessels, of smaller size. Pulmonary vessels arise from both the upper and lower vessels.

In the Erpobdella, or Leech, there is a median vessel in the dorsal region, another in the abdominal region, and one at either side. The lateral vessels are the most contractile, and the pulmonary vessels both arise from, and terminate in them. The manner in which the blood circulates through them is not fully understood. According to J. Muller, the median vessels contract at one time with one of the lateral vessels, and the next time along with the other.

The *Arachnida* (as the spider and mite) possess a system of arteries and veins and a dorsal elongated heart. They all breathe through stigmata or pores on the surface, which in some instances lead to tracheæ, and in others to pulmonary sacs.

The *Insecta* have a dorsal vessel or heart, which propels the nutritious fluid, but afterwards it is diffused throughout the cellular tissue of the body.

Professor Carus, in the year 1824, observed a distinct circulation in the larva of the *Agrion puella*. On either side of the body currents, containing globules (but not contained in vessels) were seen to pass towards the posterior end of a dorsal vessel: having entered this, they are propelled by its pulsations to its anterior extremity, where they issue, and repeat the same circuit. See *Carus, Anat. Trans.* Appendix, vol. ii.

In the *Ephemera marginata*, the blood discharged from the anterior extremity of the dorsal vessel is returned, not only in lateral diffuse streams, as abovementioned, but there are moreover distinct vessels, one on each side, of a serpentine form, which convey a portion of it to the posterior end of the dorsal vessel: the legs, tail, and antennæ, are supplied by branches, setting out from the lateral vessels, and returning to them in the form of loops. In proportion as the insects approach to maturity the vessels gradually disappear, till at length nothing remains visible but the dorsal vessel, and certain minute branches of it, which are distributed to various organs. — See Roget's *Bridgewater Treatise*, vol. ii. p. 241.; and Bowerbank, in *Entomological Magazine*, vol. i. p. 239.

## MOLLUSCA.

The *Cirrhopoda* are classed by Dr. Grant with the *Articulata*, on account of the diploneurose form of their nervous system: they have a dorsal elongated heart, and vessels can be distinctly seen in the ciliated processes; but their vascular system has not been as yet sufficiently investigated. Poli affirmed that he saw a pulsating heart situated above the anus.

The *Brachiopoda* derive their name from having at the sides of the mouth two arms, that serve as feet: they have two aortic hearts, not divided into auricular and ventricular portions. The propriety of separating them from the Acephala has been called into question by many modern physiologists.

The *Acephala* are so termed on account of their not possessing any distinct head: they are divided into *the tunicata*, which possess

no shell, and *the testaceous*, which are provided with a shell, consisting of two valves.

To the former division belong the *Ascidia*, which are either simple or compound. They are termed simple or solitary when they are separate individuals and compound, when a number of them are connected by their origin from a common polypiferous stem. The solitary Ascidia have the simplest heart of all the mollusca: it consists of a thin membranous ventricle, apparently without valves. From the heart the blood is conveyed over the system generally; and on its return is aërated in its passage through the gills. In the compound Ascidia Mr. Lister observed a remarkable peculiarity: each individual possessed a heart, consisting of a single cavity, and pulsating thirty to forty times in a minute. From this the blood was propelled through the gills in the first instance (in which respect its course differed from that in the simple Ascidia), and was then diffused over the system; after which it passed into the common stem: it then returned in the opposite direction, and repaired to the heart of *a different branch*; and in this way the circulation was common to all. Mr. Lister also observed that every two minutes, or less, the direction of the current was reversed. On separating one of the Ascidia, the circulation was carried on independently of the stem; but the alternation of its direction continued as before.

The testaceous Acephala possess a single ventricle of an elongated symmetrical form, and situated on the middle line in the dorsal region. The ventricle is surrounded by the rectum, so as to appear perforated by it. On either side is an auricle, the apex of which terminates in the lateral part of the ventricle, and the base turned outwards receives the pulmonary veins. From the anterior extremity of the ventricle arises the great artery for the anterior part of the animal, and from its posterior extremity arises the vessel that supplies the stomach, liver, intestines, and ovary. The blood having circulated through these parts, passes through the general venous system to the branchiæ, and thence by the pulmonary veins to the auricles.

There are some exceptions to the above arrangement. Thus, in the Ostracean family, the ventricle is unsymmetrical, and the auricle single; and when the back is broad, as among the Archidæ, there are two ventricles as well as two auricles.

In the *Gasteropoda* and *Pteropoda* the heart generally consists of a single auricle and single ventricle. The ventricle propels the blood over the system generally; after which it is aerated either in the branchiæ or pulmonary sacs and returned to the auricle. In some, however (as the Scuti-branchiate and some of the Cyclo-branchiate), the auricle is divided, as in the conchiferous mollusca, and in some of these there is a farther analogy, in consequence of the rectum piercing the ventricle.

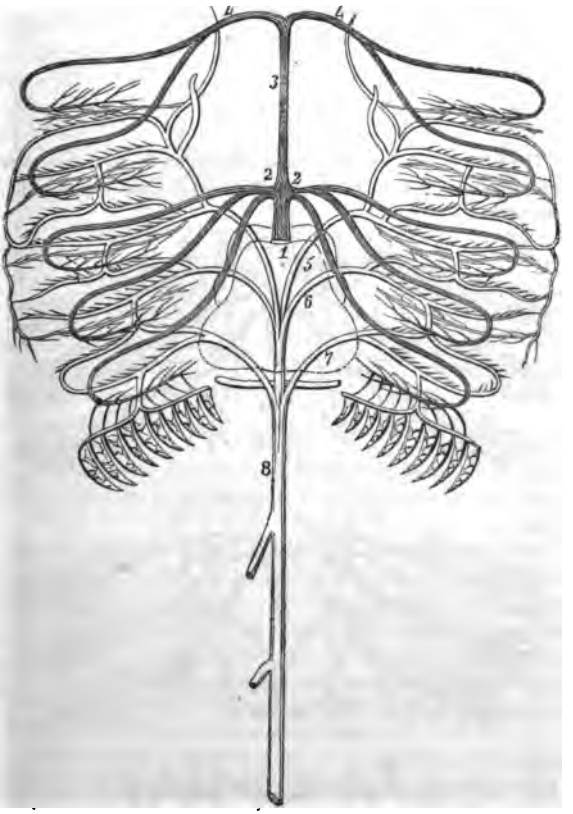
The *Cephalopoda* (as the cuttle-fish) derive their name from having their feet attached to the head. There are two divisions of these animals.

The first division includes those having four branchiæ — the Nautilus Pompilius may serve as an example. In this animal there is but one heart; it consists of a thick ventricle, from which two arteries arise, a superior or lesser aorta, and an inferior or greater. The blood being propelled through these to the system generally, is returned by veins which terminate in a sinus, from which arise four branchial arteries, two on each side, that convey the blood to the gills, from which, after being oxygenised, it returns by four branchial veins to the ventricle.

The second division of the Cephalopods consists of those having two branchiæ. Of these the cuttle-fish is an example. In these animals we find that there are three hearts; the central heart propels the blood over the system. It then returns by a vena cava, which divides into two branches; one proceeds to each branchial heart. This heart propels it through the gills, and it returns by the branchial veins to the central heart.

## FISHES.

In fishes the heart is single, consisting of one auricle and one ventricle. The venous blood from the liver and body generally is received into the auricle, from which it passes into the ventricle. From this cavity it is propelled into an arterial tube; on the commencement of which is, in most cases, a dilatation, termed the *bulbus arteriosus*. (See *fig.* p. xvii. representing the circulating organs in the skait, taken from Martin St. Ange's plate.



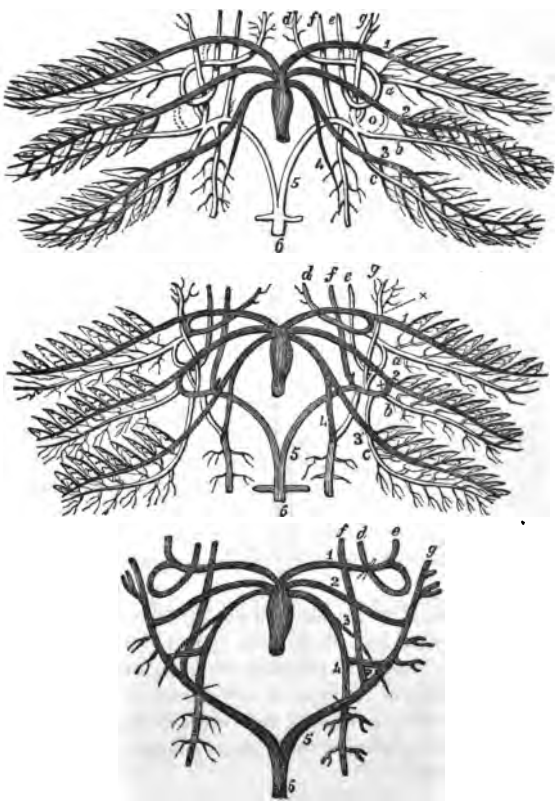

The branches of the arterial tube issuing from the heart, subdivide, till they terminate in the gills. The blood becoming arterialised here, passes into returning branches, which ultimately uniting with those of the opposite side, forms a common aorta. The aorta transmits the blood to the system generally; and this blood is afterwards returned to the single auricle by the cava and vessels of the liver.

The *Portal System.* — The veins from the abdominal viscera

and posterior parts of the body form the portal system, the blood of which is distributed to the kidney and liver.

## REPTILIA.

The next class of animals whose circulation we have to review are termed reptiles, consisting of Batrachia, Chelonia, Ophidia, and Sauria.



### 1. Batrachia.

Batrachia (as frogs and salamanders) are distinguished from all other reptiles by undergoing metamorphoses, principally affecting their circulating and respiratory organs and their limbs. In their first stage, or state, they lead an aquatic life, like fishes. They have a heart, consisting of one auricle and one ventricle, and they breathe by gills. In their next state, their lungs, which were at first but rudimentary bags, become developed; and they still possess branchiæ, and are therefore amphibious. Some of them remain permanently in this state, as the proteus, siren, &c., and are therefore called perenni-branchiate; while others, as frogs and salamanders, pass on to a third stage, in which they lose their gills, and breathe entirely by lungs: these are called caduci-branchiate.

*Caduci-Branchiate Batrachia.*

The wood-cut (p. xviii.) represents the circulating system of one of this class (the Salamander Cristata) in each of these stages.

*In the first stage*, all the blood of the heart is venous, and in this state is sent from the ventricle to the gills by three branchial arches on each side (1, 2, 3); and the inferior arch detaches a small branch (4) to the rudimentary lung. Corresponding to each branch is a returning vessel (*a b c*), which brings back the blood in an arterial state from the gills. The highest of these returning vessels gives branches upwards, but the second and third unite on each side to form a lateral trunk (*5*); the two lateral trunks unite to form a descending aorta.

Hence we see that at this stage of the animal's existence the entire blood passes through the gills before it is distributed to the organs, as in fishes.

*In the second stage* we find that the branchiæ are smaller and situated internally. 2. We observe, that each of the two highest arches (1 and 2) going to the gills, sends an anastomotic vessel (*o*) to the returning branch. [The rudiment of these anastomotic vessels had existed in the first stage (see dotted lines in the first figure), but being so extremely diminutive were not taken into account.] Now it is obvious that, since the anastomotic branches are situated on the cardiac side of the gills, they will divert from

each of them a portion of blood, and will transmit this in the venous state to the returning vessels, which, as we have already seen, give off the arteries of the body; and now, consequently, as the returning vessels also contain arterialised blood coming from the gills, all the organs will be supplied with mixed blood, and not with pure blood, as in the first stage. Lastly, we may observe that the branch (4), which the inferior or third arch sends to the lung, becomes much enlarged, and the lung itself more developed, while the branch of the same arch to the gills diminishes in proportion. In this state the animal is truly amphibious.

*In the third stage* (see *fig.* 3. p. xviii.), the animal acquires a pulmonary circulation, and the branchiæ disappear. The changes which occur in the vessels are as follows: — It may be remembered that the inferior arch on each side sends one branch to the third gill, and one to the lung. Now, the branch to the lung enlarges, and the lung by degrees becomes fully developed. This diverts the blood from the gills. The branch to the gill becomes at first smaller, is afterwards obliterated, and the gill at length disappears. The first and second gill also disappear, owing to the continuation of the causes that produced their diminution in the second stage. For the anastomotic ducts (*o*) enlarge considerably, so as to form a communication between the branchial arch and its returning vessel, and thus convert the two vessels into one, and at the same time to gradually exclude the two upper gills from the circulation. Now a glance at *fig.* 3. p. xviii. shows that, on each side, the inferior arch, which formerly supplied the gill, has now become the pulmonary artery; and, inasmuch as the two upper arches of each side give off all the vessels of the body, we will find that, in proportion as the gills become excluded from the circulation by enlargement of the anastomotic vessels, in the same proportion must the blood, supplied to the body, become more venous, till at length the gills cease to exist, and the blood is circulated unaltered from the state in which it was sent from the heart, that is, in nearly a venous state.

At this period, the heart has *two* auricles and one ventricle, as proved by Dr. Davy, who was the first that discovered the left auricle.

*Perenni-branchiate Batrachia.*

In this manner we trace the development of the caduci-branchiate. As for the perenni-branchiate (*as the proteus and siren*), they resemble in their first state the tadpole of the caduci-branchiate. Like them also the auricle changes from a single to a double one, as proved by Mr. Owen; they differ, however, in their gills remaining permanently, and being always external, and in their respiratory bags not acquiring a like development.

2. Chelonia and Lacertæ.*

2. *In the Chelonia* (as the tortoise and turtle), and *Lacertæ* (as the lizard and chamelion), the heart consists, as in the adult Batrachia, of two auricles perfectly separate from each other, and a single ventricle. The ventricle, however, contains a peculiar muscular valve, represented at (6) in *fig.* p. xxii. and (A) in *fig.* p. xxiii. This performs the office of a valve to both the auriculo-ventricular openings. As the Chelonia and Lacertæ breathe by lungs exclusively, they have no vessels corresponding to the branchial vessels of the Batrachia; and it may also be observed that the *pulmonary* artery arises directly from the ventricle, and is not a branch of the aorta, as in the Batrachia.

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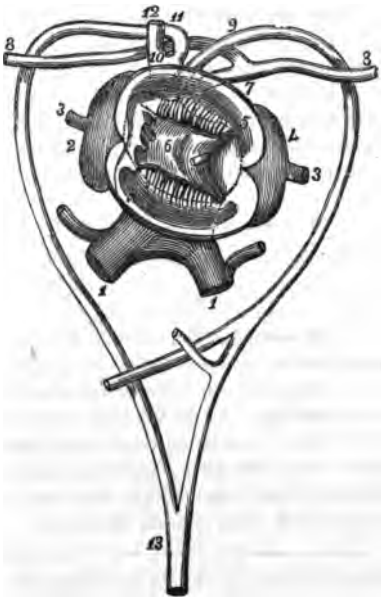
* In order to introduce M. St. Ange's discoveries, it becomes necessary to subdivide some of Cuvier's divisions, as the following table will explain.

Cuvier's Division: —

| | | | |
|---|---|---|---|
| *Sauria*, which I divide into | | *Crocodili.* | 4. |
| | | *Lacertæ.* | 2. |
| *Ophidia* | - - - | *Ophidia.* | 3. |
| *Chelonia* | - - - | *Chelonia.* | 2. |
| *Batrachia* | - - - | *With permanent Branchiæ.* | 1. |
| | | *With temporary Branchiæ.* | |

Now I consider these, not in the order in which they stand, but in the order in which they are numbered; as this leads us, by a gradual transition, from those that have circulating organs resembling fish, to those that have them more analogous to warm-blood animals. The same number stands opposite the Chelonia and Lacertæ, implying the similarity of the circulating organs.




*In the turtle* the venæ cavæ (1 1) convey the venous blood to the right auricle (2), and the pulmonary veins (3 3) convey it to the left auricle (4); from both auricles it passes into the common ventricle (5); the common valve (6) prevents the blood from returning into either auricle, and accordingly it passes into the three great vessels issuing from the ventricle. One of these (7) is the pulmonary artery, dividing into two branches (8 8); the second (9) is the right aortic arch, while the third (10) gives off the left aortic arch (11), and the carotid artery (12). The aortic arches subsequently meet, and form the descending aorta (13).

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* In the tortoise, the branches of the pulmonary artery send ductus arteriosi to the aortic arches.

*In the lizard tribe,* the three vessels issuing from the heart are

disposed as follows: — One is the pulmonary artery, and divides into two branches for the lungs; the second is the left aortic arch; and the third is the right aortic arch. This last vessel, soon after its origin, sends upwards a branch which divides into a right and left arch, which first passes above and parallel to the right and left aortic arches, and then unite with them where they begin to descend. In this manner here is a double arch formed on each side.

### 3. Ophidia.

In ophidia, or serpents, the heart consists of four chambers, viz. two auricles, which are distinct, and two ventricles, which communicate by a large opening. The right auricle receives the blood from the cavæ, and the left auricle from the single pulmonary vein. From the auricles the blood passes into the ventricles, and here the black and red blood become mixed, and the ventricle is consequently common. From the common ventricle arises — 1st, a pulmonary artery, conveying mixed blood, which, after being oxygenised, is returned to the left auricle; 2dly, a left aortic arch; and, 3dly, a right aortic arch, which gives off the carotid.

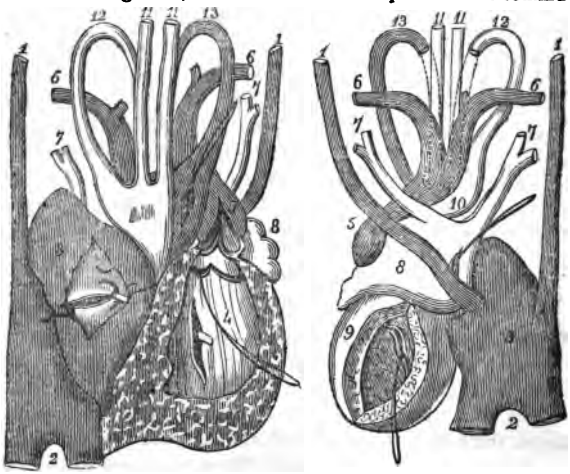
### 4. Crocodill.

In the Crocodile the heart consists of two auricles that do not communicate, and also two ventricles equally distinct from each other. Hence it appears that it is exactly similar to that of warm-blooded animals; but still we find that, though the pure and impure blood are thus separated in the heart, they mix before they are distributed to the organs, — as will appear by referring to the two accompanying figures, which represent the arrangement of the principal vessels in this animal.

The first figure (in p. xxiv.) is an anterior and the second a posterior view of the heart.

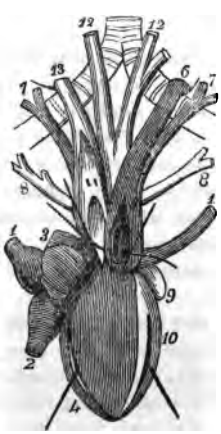
(1.) The superior cavæ; (2.) the inferior cavæ; (3.) the right auricle; (4.) the right ventricle; (5.) the pulmonary artery; (6.) its branches; (7.) the pulmonary veins; (8.) the left auricle; (9.) the left ventricle, in which a bristle is seen passing through the auriculo-ventricular opening; (10.) a trunk from the left

ventricle, which gives off; (11.) the carotid arteries; and, (12.), the descending aorta, the blood of which is pure until it commu-



nicates (see dotted lines) with (13), which is a branch from the right ventricle: so that pure blood is sent to the head, and mixed blood to other parts.

In the Crocodilus Lucius the mixture of the blood is effected in a different manner, as will appear by reference to the annexed *fig.*, where (1 1) are the superior cavæ, and (2) the inferior cava, for conveying blood into (3) the right auricle. From this it passes into (4) the right ventricle, then into (5) a trunk common to the right aortic arch (6), and the pulmonary arteries (7 7); after being arterialised, it returns by the pulmonary veins (8 8) to the left auricle (9.), and left ventricle (10.): it gets into (11), which is a trunk common to the carotid arteries (12 12), and the right aortic arch (13). Now, the peculiarity here referred to is the transverse communication between



the trunk (5.) and (11.), which arise from the right and left ventricles. A bristle may be seen passing horizontally through this opening. It should be observed that it is during the dilatation and not during the contraction of the ventricle the blood passes from one trunk to the other.

*Portal System in Reptiles.* — In reptiles, as well as in fishes, there is a double portal circulation, one belonging to the liver, and the other to the kidneys. In some reptiles, all the blood returning from the posterior parts of the body circulates through the portal system; in others, part of it goes to the vena cava directly.

## BIRDS.

In birds, the heart (inclosed in its pericardium) consists of two auricles, separated by a perfect septum, and two ventricles equally distinct. It therefore resembles the heart of man; but there is, in the right ventricle, a peculiar muscular valve, instead of the membranous valve observed at both auriculo-ventricular openings in mammalia, and at the left auriculo-ventricular opening in birds. This valve has a convex margin, which is attached, and a concave margin, which is free, and looks towards the convex surface of the septum ventriculorum. During the contraction of the ventricles, the concave margin is firmly applied to the septum, so that the ventricle is completely closed at all points, except at the pulmonary orifice. According to Blumenbach, this provision for forcibly propelling the blood into the lungs is more necessary in birds than in mammalia, "since the expansion of the latter organs by respiration, which facilitates the transmission of carbonated blood in mammalia, does not take place in birds, on account of the connection which their lungs have with the numerous air-cells."

*The Arterial System in Birds.*—From the right ventricle arises the pulmonary artery, and from the left the aorta. This latter vessel almost immediately gives off a left innominata, and then a right innominata; while the continued trunk, or arch of the aorta, curves over the *right* bronchus, and descends along the spine.

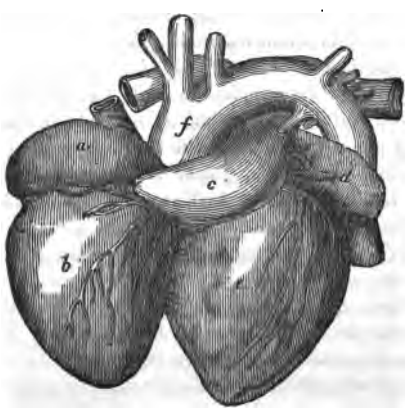
The arteria innominata, of either side, divides into a subclavian artery and a trunk common to the carotid and vertebral arteries. The pectoral branches of the subclavian are remarkable for their great size. The vertebral artery, having arrived near the head,

terminates entirely by inosculation with the occipital branch of the carotid artery. The carotid gives off various branches, and amongst the rest one that is analogous to the internal carotid, which forms in the cranium an anastomosis analogous to the circle of Willis. The branch, however, that represents the basilar artery is supplied entirely by the anastomosis of the carotids.

The descending Aorta gives off no phrenic artery (the diaphragm being deficient), nor any special emulgent artery (the kidney being supplied from several sources). Lastly, it supplies the lower extremities by a small femoral branch, and a large ischiadic trunk, which escapes from the pelvis through the ischiadic foramen.

## MAMMALIA.

*In Mammalia*, the heart consists, as in birds, of two auricles and two ventricles. In the human subject, in the ourang outang, and in the mole, its apex is turned to the left side. In the bisulca, two small flat bones are found at the base of the left ventricle. Lastly, in *the Dugong* (see *woodcut*), the heart is bifid,




the right and left ventricles being separate at their apex. I shall have occasion, farther on, to allude to the large vessels issuing from and terminating in the heart, and contrast them in man and other mammalia.

## I. The Heart in Man.

The descriptive anatomy of the heart will be found farther on. The following observations are of a general nature: —

The heart of adult man, like that of other mammalia, consists of two separate auricles and two separate ventricles, inclosed in a membranous bag or pericardium. The auricles, situated at the base of the heart, are formed of comparatively thin muscular parietes. The left one receives the oxygenised blood returning from the lungs, and propels it into the left ventricle, after which it passes into the aorta and is diffused over the system. The right one receives the blood from the system generally, and propels it into the right ventricle, whence it passes through the pulmonary artery to the lungs to be oxygenised. As the ventricles, therefore, have to propel the blood to a considerably greater distance than the auricles, their parietes are consequently considerably thicker; and, for the same reason, the left is very much thicker than the right ventricle. The muscular tissue of the heart is coated by two membranes; the exterior one is the reflected serous layer of the *pericardium*, and the internal one is continuous with the lining membrane of the arteries and veins, and has lately been termed the *endocardium*.

When the auricles contract, the ventricles dilate, and *vice versâ*. The arteries contract at the same time as the auricles, and the veins at the same time as the ventricles. When the heart is said to contract, we always mean the contraction of the ventricles. The contraction of the heart is technically termed its *systole*, and its dilatation is termed *diastole*.

*Exciting Cause of the Heart's Contraction.* — The blood contained in the heart has been supposed to be the cause of its contraction; exciting it, according to some, by its chemical properties, and according to others by the stimulus of distension. It is sufficient to refute both these opinions, that the heart will continue to contract and dilate, when it is recently separated from the body and empty, as shown by Mr. Herbert Mayo and several others. A third cause assigned is the stimulus of the nervous power. Le Gallois, indeed, was of opinion that the heart contracted independently of the nervous power; finding that it continued to beat after the spinal marrow was crushed. But his ex-

periment is quite inconclusive. For, first, he has overlooked the fact, that the nerves themselves are capable of generating nervous power sufficient to excite it; and, secondly, Mr. Wilson Philip has found that, if the spinal marrow be crushed *gradually*, and not instantly, as in Le Gallois's experiment, the heart will continue to beat for some time notwithstanding. I am therefore disposed to refer the contraction of the heart to the stimulus derived from the nerves supplying it.

*Force of the Heart's Contraction.* — Borelli calculated that the force of the heart was equal to 180,000 lb.; while Keill was led by his calculations to estimate its force at $5\frac{1}{2}$ ounces!

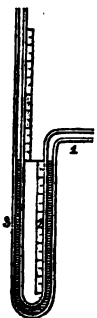
*Borelli* assumed that the power of a muscle was proportioned to its weight; and having ascertained the weight of a deltoid muscle, and the power of this muscle in a living man, next weighed a man's heart, and argued that, as the weight of the deltoid muscle is to its power, so is the weight of the heart to its power. The three first quantities being known, the discovery of the fourth was effected by a simple sum in the rule of three.

*Keill* had recourse to a very complicated process, an account of which will be found in Dr. Bostock's *Physiology*, by those who are desirous of learning the history of this inquiry.

*Hale's* experiments were made with a view of ascertaining the amount of pressure which the blood, impelled by the heart through the arteries, was capable of exerting at any part of the arterial system. For this purpose he opened, in various animals, a large artery, and inserted into it a long glass tube, and marked the height to which the blood ascended in it. The pressure of the blood in the aorta of a horse having been ascertained in this manner to be equal to 11 lb. he computed (by comparison of the size of their body or vascular system with that of man) that in the human aorta it would be equal to 4 lb. 6 oz., and that if the glass tube were inserted into it the blood would rise to $7\frac{1}{2}$ feet. Now, if the inner surface of the human heart (which he calculated at 15 square inches) be multiplied into the pressure of such a column, it will follow that the pressure on the internal surface of the human heart will be about $51\frac{1}{4}$ lbs., or, in round numbers, 50 lb.

*Pouseuille* proceeds on the same principle; but in place of a straight tube, he employs a bent one, which he names a *Hæma-*

*dynamometer.* This instrument is a long glass tube bent so as to consist of a short horizontal branch united at a right angle to a descending branch, which curves inferiorly, to be continuous with a long ascending one (see *woodcut*). Mercury poured into the ascending or descending branch will necessarily rise to the same level in both. If, therefore, the horizontal portion of the tube be inserted into a wound in an artery, the blood will exert on the mercury a pressure equal to the force with which it is moved in that artery. The mercury will consequently be depressed in the descending tube, and rise in the ascending one, and the height to which it rises will be indicated by a scale attached to the instrument. By introducing some carbonate of soda between the blood and the mercury, he prevents the former from coagulating. From experiments with this instrument, he estimates the force of the blood in the commencement of the human aorta at 4 lb. 3 oz., which is nearly the same result as that obtained by Hales. They differ, however, as to the manner in which they deduce the power of the heart from this result; and Pouseuille makes it amount to only 13 lb.




*The Dilatation of the Heart.*— It was formerly supposed that the heart was passive in its dilatation; that is, that it merely yielded to the distending force of the blood which entered it. Bichat's experiment proves the contrary. He introduced one hand within the heart of an animal, and with the other grasped its exterior. The result was, that though there was no internal pressure, the distension of the heart tended to open the hand on its outside as strongly as it closed on the hand within. Mr. Mayo, likewise, found that the heart of a dog, torn from the chest during life and thrown into water, continued for some time to contract and dilate as before, though under these circumstances the pressure on both the internal and external surfaces must be equal. Bostock ascribes the dilatation of the heart to its elasticity. If this opinion were correct, it would be found in a state of distension when its contraction had ceased after death.

*The cause of the alternate contraction and dilatation of the heart* cannot be satisfactorily assigned. Some have supposed that, in a part of the circulating system, a stimulating matter is contained,

which makes that part of the circle contract; in consequence of which the stimulating matter is propelled into the next part of the circle with the same effect, and so on. According to another hypothesis, during the contraction of the heart, the nerves supplying it are compressed; this produces a paralysis or relaxation of its fibres, the effect of which is to remove the pressure from the nerves, and so the heart recovers its power, and contracts again. These speculations lead to no actual knowledge, but they show that there is considerable difficulty in the subject, and that the inquiry has not been neglected.

*The Action of the Heart not constant.* — We shall find further on (p. xxxii.) that in every beat of the heart only the half of the beat will be occupied by the contraction of the ventricles. If, therefore, there be 60 beats in a minute, the ventricle will be free from contraction during the half of every minute; that is, during twelve hours in the day. Now the half of these twelve hours is occupied in its dilatation, and during the remaining half it is at rest.

*The Irritability of the Heart after Death.* — Several physiologists have proved by experiment, that the heart will continue to beat after it has been removed from the body. In cold-blooded animals its contraction has been observed for 30 hours; and in a warm-blooded animal, Haller observed it to continue for 7 hours. After its contraction has ceased, it may be renewed by immersing it in warm water, and by the use of various stimulants. It is remarkable, that the internal surface is considerably more sensible to stimuli than the external, and its sensibility lasts for a longer time. The irritability of its different chambers cease in the following order; — left ventricle, right ventricle, left auricle, right auricle. The right auricle has been accordingly termed the *Ultimum moriens.* Haller ascribed the protracted irritability of the right side of the heart to the circumstance of its containing blood after the left side was empty. To test the correctness of this opinion, he performed the following experiment: — He obstructed the escape of blood from the left ventricle by ligature of the aorta, and emptied the blood of the right side by division of the venæ cavæ and pulmonary arteries. The result of this experiment was that the right side ceased to act before the left, because, as he inferred, it was sooner deprived of the stimulus of the blood.

The result of this experiment, however, does not by any means imply that the heart was excited to contraction by the *specific properties* of the blood; for in this case, the unnatural *distension* of its left side, in consequence of the ligature of the aorta, may have acted as a stimulus. It merely proves, in my opinion, that after the contraction of any part of the heart has ceased, its action can be renewed by excitement.

*Impulse of the Heart.*—During the contraction of the heart, its apex strikes against the anterior wall of the thorax and causes a shock, which is termed its impulse. Now, if the apex of the heart approaches its base during the contraction of this organ, ought it not to recede from the anterior wall of the thorax, instead of striking against it? How are we, then, to explain its impulse? — Some have supposed, contrary to all observation, that the heart became elongated during its contraction. Senac attributed the impulse to the straightening of the two great vessels at its base, and to the filling of the left auricle during the contraction of the ventricle. Dr. William Hunter supposed it was solely the effect of the arch of the aorta becoming straighter, and therefore longer, by the influx of blood. Carson and Muller have shown that the aorta would not become straighter under those circumstances, and Dr. Corrigan justly observes, that if it did, it would carry the heart to the right side, and not forwards. Lastly, Stokes and Burdach maintain that the impulse is caused, not by the contraction of the ventricle, but by the distension that precedes it. Mr. Carlisle gives a very ingenious explanation of it. He observes, that the anterior fibres of the heart are longer than the posterior, and therefore in their contraction will lose more of their length, and consequently must have the effect of bringing its apex forwards.

*Sounds produced during the Heart's Contraction.*—If the ear be applied to the chest of a healthy individual, two distinct noises are heard, like the *tic tac* of a watch, or the double *claquement* of the sucker of a pump. The first is dull and prolonged, and corresponds exactly with the impulse of the apex of the heart against the parietes of the thorax, which we shall find to occur during the systole of the ventricles. The second noise is shorter, smarter, and clearer: Laennec compared it to the noise of a dog lapping, or the valve of a pair of bellows: it will be found to occur

during the diastole of the ventricles. To this double noise succeeds a silence corresponding to the repose of the ventricles.

Now, these two sounds of the heart, and the silence that succeeds them, constitute *a beat;* and as there are, in some adults, about 60 beats of the heart in a minute, each beat will occupy the sixtieth part of a minute — that is, a second of time; the dull sound occurring during the first half of the second, and the second sound and silence occupying a quarter of a second each. — To explain the causes of these sounds, various theories have been framed, of which we may now take a rapid review.

1. *Laennec's Theory* supposes the first sound to depend on the contraction of the ventricles, and the second on that of the auricles, or (as he afterwards modified it) of the auricular appendices. The objections are, that no other muscles produce a similar sound during their contraction; and that Dr. Hope has shown that the contraction of the auricle occurs during the silence of the heart, and therefore cannot be the cause of the second noise.

2. *Pigeaux's Theory* ascribes the first sound to a vibration of the ventricles, in consequence of the blood being launched against their parietes with force, and the second noise to the vibration of the parietes of the aorta and pulmonary artery from a similar cause. According to this theory, the contraction of the auricles propels the blood against the parietes of the ventricles, and their vibration causes the first sound; next follows the silent and rapid contraction of the ventricles, propelling the blood against the aorta and pulmonary arteries, the vibrations of which produce the second sound; lastly, during the silence of the heart, the blood is arriving in the auricles, and the auricles are contracting. This theory is refuted by Dr. Hope's observations, which prove that the systole of the heart and first sound are isochronous.

3. *Dr. Hope's Theory.* — Dr. Hope's observations were made on asses, in which insensibility was produced, artificial respiration kept up, and the heart exposed by sawing through the left ribs near the sternum, and reflecting them. In animals thus circumstanced, he found that the heart, distended or not, was *always full;* and that the contraction of the auricles, which scarcely extended over a fifth of them, was propagated to the ventricles without interruption, so that the contraction of auricles and ventricles seemed one continuous movement. In small animals, the ventricle is emptied

by its contraction, as appears from its paleness; but this is not the case in larger animals.

The first sound he found to be synchronous with the impulse of the apex of the heart against the chest, and with the systole of the ventricle; and was caused, in his opinion, by the collision of the particles of blood in its interior: the second sound accompanied the dilatation of the ventricle, and was caused by the rush of blood from the auricle, together with the succussion consequent on the ventricle ceasing to be distended; lastly followed the period of silence; during the first half of which the auricle (which was at all times full) became distended, and in the second half of this period the auricle contracted, commencing at the auricular appendix, and extending *without interruption* to the ventricle, the contraction of which renewed the first sound, and the series was repeated as before.

4. *Magendie's Theory.* — According to Magendie, the first noise is caused by the percussion of the thoracic parietes by the apex of the heart during the contraction of the ventricles, and the second noise by the percussion of the same parietes by the anterior surface of the heart during the dilatation of the ventricles. In support of the theory he urges, 1st, that when there is considerable effusion into the cavity of the pericardium, the noises of the heart are not heard; 2dly, that they are not heard in hypertrophy of the heart, in consequence of there not being room enough for that organ to strike. Now, the correctness of both these statements have been denied by several accurate pathologists. Lastly, he observes, that if the sternum of an animal be removed, the noises cease. This also is directly contradicted by the experiments of Bouillaud, Desclaux, Hope, and Raciborski.

5. *Rouanet's Theory.* — According to Rouanet, the first noise is heard at the commencement of the contraction of the ventricle, and is caused by the impulse of the blood against the auriculo-ventricular valves, and their sudden change from a flaccid to a tense state; while the second sound is produced by a similar change in the state of the semilunar valves.

This theory has been adopted by Bouillaud, with some modifications. It should be mentioned, however, that Piorry affirms that he could imitate the natural sounds of the heart by injecting water into the heart after the valves had been cut away.

*Development of the Heart.*

The human heart is later in its development than either the aorta or portal system, at the junction of which it first appears in the form of a tube. From this form, in which it is analogous to the dorsal heart of insects, it passes to another stage, in which it resembles that of fishes, having one auricle and one ventricle; — when the ventricle is single, both the aorta and pulmonary artery arise from it. At length the septum commences near the apex, and gradually extends towards the base; and this explains why the aperture is usually* found in the latter situation, where, in consequence of arrest of development, there remains permanently a communication between the ventricles. A septum also forms between the right and left auricles, proceeding from above down; but even at birth, there is a free communication between them, the reason of which which will presently appear.

During the first few months of fœtal existence, the heart is not oblique, but vertically directed, as in brutes.

Its form is more rounded than in the adult, and likewise more symmetrical, — the cause of which will be hereafter explained (see p. xxxvi.). The auricles are particularly large in proportion to the ventricles.

The volume and weight of the heart are great in proportion, insomuch that in the fœtus of four or five weeks the heart fills the whole cavity of the thorax; and if we compare the relative weight of the heart and whole body at different periods, we find that the former gradually diminishes; thus, at the end of the third month it makes a fiftieth part of the weight of the body, while at the end of the ninth month it is barely one hundred and twentieth.

The muscular fibres of the heart are more distinct in the fœtus than in the adult; they are also free from the adipose matter which we often find at the base of the adult heart, particularly in corpulent and aged persons.

Lastly, the heart is bifid in the early fœtus, like the heart of the Rytina and Dugong. (P. xxvi.)

Such are the general characters of the heart at different periods of intra-uterine life. But if we desire to obtain more detailed in-

* Sometimes it is in the centre of the septum, as in a case related in Dr. Davies's Lectures on the Chest, p. 510.

formation in reference to the fœtal circulation, it will be necessary to attend more particularly to the development of the right auricle I shall therefore present the reader with the results of the investigations of M. St. Ange, to whom, in 1832, the Académie des Sciences de l'Institut de France awarded the prize of experimental physiology, for his researches on the circulation in the human fœtus. According to his observations,—"At six weeks, the interior of the right auricle presents a small oblong cavity, with smooth and thin parietes, and apparently a continuation of the two venæ cavæ. At this period the Eustachian valve is simply a continuation upwards of the outer wall of the inferior cava, and extends to the upper part of the foramen ovale in the form of a crescent, the concavity of which looks upwards. Its left margin is attached to the internal (anterior) pillar of the fossa ovalis. Its right extremity is attached to the internal wall of the auricle, on which it is continued sufficiently high to cover the orifice of the superior cava; after which it is lost on the fleshy band which lies at the upper and inner part of the orifice of this vein. Behind the Eustachian valve, which thus forms a distinct partition, are the orifices of both the venæ cavæ and the foramen ovale. The posterior wall of the inferior cava passes behind the pillars of the foramen ovale (that is, into the left auricle), and ascends as high as its crescent (or arch formed by their junction). This is an important fact, as most anatomists maintain that the valve of the foramen ovale forms a curve, the concave edge of which looks upwards; and that from this disposition results a free permanent opening of a circular form. Now the truth is, on the contrary, that the crescent formed by this valve disappears the moment the auricles are completely filled with blood, and thus the occlusion of the foramen ovale follows."

"At two months the right auricle has become sufficiently large to be examined with the naked eye. The crescent of the Eustachian valve describes a larger curve, and allows a freer communication between the anterior and posterior cell of the auricle. At two months and a half, the orifice of the superior cava is higher up, but still covered by the Eustachian valve. At three months and a half, there is but little of this vein covered by the valve, and now therefore the blood of the two cavæ mix in the whole auricle, and not in its posterior cell only. In the course of the fifth

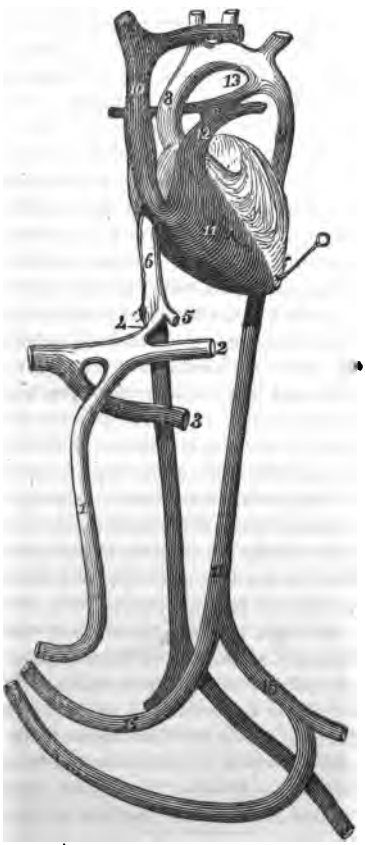
and sixth month, the valve is diminishing in size; and at the ninth month it leaves uncovered the foramen ovale and orifices of both venæ cavæ. As for the coronary vein, it is obvious, that as it opens in front of the Eustachian valve, it empties its contents into the anterior cell."

When we consider that before birth the respiratory organs are not employed in their special function, but lie collapsed in the thorax, we perceive why, at this period, it is expedient that no more blood be sent to them than is necessary for their nutrition; whereas, instantly after birth, the entire of the blood must circulate through the lungs, in order to be oxygenised. Some contrivance is therefore necessary to adapt the circulating organs for these two varieties, and for the rapid change. Accordingly, we find that in the fœtus there is a beautiful mechanism, by which the blood of the right auricle is turned off from the lung so long as the latter remains unexpanded, but capable of being so altered by respiration as immediately thereupon to allow the entire blood of the body to circulate through the lungs. This I proceed to explain: — First, *all* the blood of the body passes through the right auricle; and lest the entire of this should be transmitted (as in the adult) through the right ventricle into the lung, there is a valvular opening in the septum of the auricle (the foramen ovale), allowing the greater part of it to pass into the left auricle, and thence through the left ventricle and aorta, to be diffused again over the system. Consequently a small proportion only goes to the right ventricle and pulmonary artery; but even of this small proportion, a considerable quantity is again turned off by a large vessel (the ductus arteriosus) springing from the pulmonary artery, and terminating in the descending aorta. In consequence of this communication, the right ventricle is as fully employed in the systemic circulation as the left. This explains why, in the fœtus, both sides of the heart are of equal thickness, and the apex is formed by both ventricles; whereas, in the adult, it is entirely formed by the left, which is considerably stronger and thicker than the right.

### The Fœtal Circulation.

The exact course of the blood in the fœtus has not been hitherto fully agreed on. I shall pass by the opinion of Mery, who supposed the *blood* passed from the left auricle into the right, and others

who are as obviously wrong, and mention only those of Sabatier and Winslowe.




*Sabatier's Figure of* 8 *Circulation.* — The blood of the fœtus is conveyed from the placenta by the umbilical vein (1) to the liver through which it circulates, and then passes into the inferior cava. A portion of it, however, is transmitted

in a comparatively pure state (*i. e.* without having circulated through the capillaries of the liver); for after receiving the left branch of the vena portæ (3), the umbilical vein is continued in the form of a small duct (*the ductus venosus* (4)), which opens into the left hepatic vein (5), and this into the inferior cava (6). From the inferior cava the blood ascends into the right auricle, then by the foramen ovale into the left auricle, left ventricle (7), and arch of the aorta (8).

A portion of the blood thus carried into the aorta descends into its thoracic part (9); and we shall return to it presently; — the rest, after circulating through the head and upper extremities, returns by the superior cava (10) to the right auricle, and passes thence into the right ventricle (11) and pulmonary artery (12). A small part of this blood goes to the lungs by right and left branches; but the rest, conveyed by the ductus arteriosus (13), joins the blood that we left descending through the thoracic and abdominal aorta (14); and all that is not employed of it in the nutrition of the lower extremities and body, is reconveyed by the hypogastric arteries (15) to the placenta.

*Fœtal Circulation, according to Winslowe.* — The blood of the system generally passes from the superior and inferior cava into the right auricle. *One part* of this is transmitted through the right ventricle and pulmonary artery, and thence (except a supply for the nourishment of the lungs) through the ductus arteriosus into the descending aorta; — *a second, and larger, part* passes through the foramen ovale into the left auricle; then into the left ventricle and arch of the aorta, the branches of which supply the head and upper extremity. The continued stream passes into the descending aorta, mixing with that already described; and all that is not employed of it in the nutrition of the body and lower extremities, is reconveyed by the umbilical arteries to the placenta.

The principal difference between these two plans is, that, according to Sabatier, the blood of the superior and inferior cavæ do not mix in the right auricle; but that of the superior cava descends in front of the Eustachian valve into the right ventricle, and that of the inferior cava ascends behind the valve into the left auricle. Therefore, according to Sabatier, the head and upper extremities are supplied with pure blood, and the body and inferior extremities with mixed. I am inclined to think that the blood

circulates in both these ways, but at different times. Martin St. Ange has shown, that in the early part of intra-uterine life the Eustachian valve divides the right auricle into two cells, and that into the posterior cell *both* the cavæ open. Therefore, at this period, the two streams must undoubtedly mix. At a later period, however, the brain may require purer blood than other parts of the body; and as the Eustachian valve decreases in size, and the orifice of the superior cava ascends, the streams may pass each other, as described by Sabatier.

The mode in which respiration changes the course of the circulation in the human subject may be explained as follows:—After expulsion of the fœtus, and the consequent admission of air into the lungs, these organs become dilated, and allow a larger quantity of blood to circulate through them; the effect of this is to divert the blood from the ductus arteriosus, which gradually diminishes, and at length becomes obliterated. The blood thus circulated through the lungs, is returned by the pulmonary veins to the left auricle of the heart, and thus the valve at the communication between the right and left auricles is closed, — an effect that depends on the increased quantity of blood sent to the left auricle, and abstraction of the blood sent by the umbilical vein to the right auricle. In some cases the opening is persistent through life; and then an admixture of the black and red blood is the usual consequence, producing the disease termed *Cyanosis*. In several cases, however, the foramen may remain open without any mixture of the contents of the two auricles. This has been explained by the pressure on both sides of the valve of the foramen ovale having been in these cases equal. It also appears probable, that though the opening may be closed after birth, yet, in consequence of excitement or violent exertion, a communication between the auricles may be subsequently established. An interesting case of this kind is related by Dr. Davies, in his lectures on the chest. A boy in his 12th year was suddenly attacked, after violent exercise at cricket, with severe dyspnœa, dark surface, palpitations, and œdema of the limbs. His symptoms continued unrelieved till his death, which occurred six years afterwards. On examination, an opening was found in the septum of the auricles, sufficiently large to admit the thumb. Dr. Davies infers that the disease could not have been congenital, as the boy had been in perfect health previous to this violent exercise.

In the preceding account of the development of the heart, I have shown, that at different periods of intra-uterine life it consists of one, two, three, or four cavities. I now proceed to give a few instances to show that development may be arrested, and the heart found in any one of those states even after birth.

*One Auricle and one Ventricle.*—In the *Philosophical Transactions* for 1798, part ii. page 346., is related a case in which there was but one auricle and one ventricle. From the ventricle arose a large artery, which afterwards subdivided into the aorta and pulmonary artery. At the point of separation, the aorta measured in circumference twenty sixteenths of an inch (*i. e.* an inch and a quarter), and the pulmonary artery only fifteen sixteenths, consequently five sixteenths less than the aorta. The aorta gave off no bronchial artery, and there were no bronchial veins. The pulmonary veins, one on each side, opened into the superior cava.

In the *Philosophical Transactions* for 1805, part ii., is related another case of single heart; the pulmonary artery, in this case also, arose from the aorta. There were four pulmonary veins, and neither pulmonary arteries nor veins possessed more than half their usual size.

The next case to be noticed is described by Farre (*On Malformation of the Human Heart*). In this case there was but one auricle and one ventricle; the venæ cavæ opened into the auricle; and the four pulmonary veins opened in the auricular appendix, which was more than usually separate from the rest of the auricle by a kind of septum, which, however, gave passage to the blood by a large opening. The pulmonary arteries, two in number, arose from the aorta; and the heart had only one nutritious or coronary artery.

*Two Auricles and one Ventricle.*—In other cases there may be two auricles and only one ventricle, as in reptiles. Thus, Lazoni relates the case of a man, aged thirty-one years, that was subject to palpitations. He died in a state of syncope; and his heart was found very large, and consisted of only one ventricle. A second case of single ventricle is related by Senac, in his *Essay on the Structure of the Heart.* A heart of this kind was also presented by Chemineau, in 1699, to the Royal Academy of Sciences. Mr. Lawrence has a preparation in which the two auricles communicate, and have a common opening into a single ventricle, from which issue the aorta and pulmonary artery; and Tiedeman observed a similar disposition in a child eleven years old.

*Two auricles and two ventricles* may exist, yet either the former or latter cavities may communicate, or one of them may be in an imperfect state. Thus, there are numerous cases on record in which

1st. *The septum of the auricles was imperfect* in consequence of the persistent state of the foramen ovale. In almost all such cases the passage of the blood to the lungs will be found to be obstructed, either by contraction of the right auriculo-ventricular opening, or still more frequently, of the orifice of the pulmonary artery. A case of this kind lately came under my own observation, in Malahide, near Dublin. A child about four years old had been under Dr. Lloyd's care for cyanosis, and happened to die while I was attending the cholera patients in that town. We had permission to examine the body, and two policemen (one of them the child's father) remained in the room. We managed, however, to remove the heart; and we found, as we expected, the foramen ovale open, and the orifice of the pulmonary artery much contracted. In such cases the bronchial arteries are usually large, and the ductus arteriosus pervious.

2dly. *The septum of the ventricles may be found more or less imperfect.*—In some cases it is perforated (usually at its base) by a single foramen. There are so many cases of this kind on record, that it is unnecessary to give any special reference. In other cases it is perforated at many points* (see *London Medical Review*, vol. v. page 19.).

Lastly, *one of the ventricles may exist in an imperfect state.*—In a case of this kind related in the *Journal Général de Médecine*, (tome viii. 2d series, Dec. 1819), the auricles had no septum whatever, but formed a large cavity that received the venæ cavæ and pulmonary veins, and moreover, *a vein the size of a writing pen from the thymus gland.* The auricular cavity communicated with the left ventricle by an orifice about three lines in diameter, and from this ventricle arose the aorta and pulmonary artery. Immediately above the orifice of the pulmonary artery was a small open-

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* In the "*Bulletin de la Société de L'Ecole de Médecine de Paris,*" a description is given by Legallois of the heart of a rabbit, in which the septum of the ventricles was represented by a single pillar, and the pulmonary arteries arose from the aorta.

ing leading into *a cul de sac that represented the right ventricle.* There was consequently no left auriculo ventricular opening.

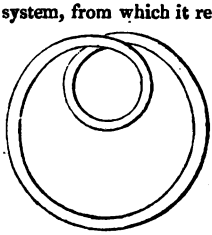
In another instance, related by Dr. Farre (*Op. cit.* p. 37.), the auricles were not completely separated, the valve of the foramen ovale not closing that opening perfectly. Both auricles opened into the right ventricle, from which arose the pulmonary artery. The right ventricle had, moreover, a small opening leading into a *pouch that represented the left ventricle,* and from this pouch arose the aorta by a free orifice.

For some other malformations of the heart, see *Irregularities of the Pulmonary Artery.*

## II. The Arteries.

The term artery is derived from the Greek words αερα τηρειν, and therefore, in its etymological sense, means an air holder. Accordingly we find that this term was originally applied to the trachea, and this use of the term prevails in many countries to the present day. Thus Cloquet and many others term the trachea the *artère aspère.* The blood-vessels, which we now denominate arteries, probably received this name from the obsolete opinion that they contained a vapour or vital spirit; and the application of the term remained after the theory from which it originated was abandoned.

As there are described in the human subject two circulations, a greater and a lesser, so there are two great arterial trunks; the aorta and pulmonary artery. The aorta, or greater, conveys the blood from the *left* ventricle of the heart to the general capillary system, from which it returns by the veins to the *right* side of the heart: the pulmonary artery, or lesser trunk, now conveys this blood from the *right* side of the heart to the lungs, from which it is returned by the veins to the *left* auricle. Consequently, it is evident that the two circles are not perfectly distinct, but are resolvable into one, in the manner that the diagram represents a cord forming a single *perfect* circle; which, however, is folded so as to make apparently two circles of different extent, and their point of junction corresponds to the situation of the heart. Each of



these great trunks divides into branches, which again divide into lesser branches, till, after a certain number of subdivisions, they terminate in the minute capillary tubes that establish a communication between the arterial and venous systems.

The number of subdivisions of the pulmonary artery, before arriving at the capillaries of the lungs, are necessarily few: those of the aorta are not very numerous. Haller ascertained that the mesenteric artery presented about twenty divisions between its origin from the aorta to its termination in the capillaries of the intestines.

When a branch is given off by an artery it usually forms an acute angle with the continued trunk. In some cases, however, it forms a right angle, and in others an obtuse one, as in the case of the superior aortic intercostals.

*Situation.*—In their course through the body, we generally find the larger arteries in situations where they can be best protected from external injuries: thus, the aorta and iliacs are lodged in deep cavities: the femoral is situated on the inside of the limb, and embedded in muscle: the same remark will apply to the axillary and brachial. Even the palmar vessels are protected by a strong aponeurosis; and the plantar by both muscle and aponeurosis. In some cases grooves or canals are formed in bones, for their greater security; as in the case of the intercostal and inferior dental arteries. The same rule applies in inferior animals. Thus, in fishes, the aorta is continued to the tail, through a channel formed by processes of the vertebræ. In the lion, the artery of the fore-leg passes through a perforation in the bone, by which it is protected in the violent contractions of the muscles. Lastly, we observe a similar perforation in the coffin-bone of the horse, for the safe transmission of arteries to the foot.

The arteries, in general, take a direct course; but in other instances present tortuosities, which have different uses and causes. 1. They allow of the extension of parts, without laceration of the vessels, and the dilatation of hollow organs; as the heart:—2. They present a greater extent of surface for the origin of branches:—3. According to some physiologists, they diminish the impetus of the blood.*

* Bichat affirms that this effect cannot occur if the vessels are

*Anastomosis.*—When arteries communicate directly with each other, they are said to anastomose. Anastomosis, by small branches, are so numerous, that there are instances of it in every part of the body. When large branches anastomose, they either communicate in form of an arch, or they converge and unite, or they are connected by one or more transverse branches.

Anastomosis *in the form of an arch* occurs in the instance of the gastro-epiploica sinistra and gastro-epiploica dextra, curving round to meet each other and unite at the convex margin of the stomach, so as to appear one continuous vessel. In this case it is obvious that, as the two currents tend to meet and oppose each other, the blood must be more or less obstructed in the trunk, and will pass off by the branches where they meet least resistance. Anastomosis *by convergence;* as where the two vertebral arteries meet at an acute angle, to form a single basilar trunk, through which the blood must, therefore, necessarily flow with greater velocity than through the branches that concurred to form it. Anastomosis *by transverse communication;* as in the case of the anterior arteries of the cerebrum, communicating by one or more transverse branches. In this case the blood is supposed to have an oscillatory motion in the transverse branch.

There are several other modifications of anastomosis, intended for different purposes in different animals.

The *rete mirabile* of Galen is found in graminivorous animals. It results from the division of the carotid artery into several small branches that subsequently unite on entering the cranium. The use of this is to prevent the brain from being injured by the

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full; but his remark is only correct when applied to canals that are *inextensible.* Sir C. Bell goes farther;—he maintains that their use is to increase the impetus of the blood. He argues principally from the tortuous appearance of vessels leading to the womb in pregnancy. (See his *Essay on the Forces that circulate the Blood.*) But may not the tortuosity, in such cases, be the effect of increased determination, rather than the cause of it? This is rendered more probable by the circumstance of the arteries of old subjects presenting tortuosities that are not found in the young, in consequence of their constant elongation by the pulses of the heart.

gravitation of the blood while the animal is grazing with the head stooped.

A remarkable plexus has been described by Mr. Hunter, in the intercostal arteries of the whale, which forms a reservoir for the blood when the animal is in deep water. Under these circumstances considerable interruption is given to the circulation on the surface, and this retreat prevents an undue accumulation of blood in the heart and large arteries.

In birds, a *rete ophthalmicum* is found at the back of the orbit; the use of which is probably to moderate the quantity of blood sent to this organ while the animal has the head stooped seeking its prey.

We likewise find in birds a *plexus of incubation*, situated beneath the integuments of the abdomen. It is formed by branches from the posterior thoracic, abdominal, sciatic, and cutaneous arteries; and its obvious use is to increase the temperature of the part during the period of incubation.

The remarkable arterial plexus discovered in the limbs of the sloth, by Sir A. Carlisle, is, in Mr. Wardrop's opinion, connected with the animal's extraordinary power of grasping and suspending itself by the limbs for a considerable length of time. (See Dr. Costello's *Cyclopædia of Surgery*, art. ANASTOMOSIS.)

*Structure of Arteries.*—An artery is readily divisible into three layers or coats; viz., the external, internal, and middle — each of which I shall consider in succession.

*The external coat* of an artery is a pale, firm membrane, consisting of closely interwoven fibres that cross the axis of the vessel obliquely. Its internal surface is closely applied to the middle coat. Its external surface (considerably less dense than the internal) is continuous with the loose cellular tissue that surrounds the vessel and constitutes its sheath.* It is the external coat that enables an artery to resist extension in the longitudinal direction.

*The internal coat* is the thinnest of the three, and is continuous

* The sheath is badly marked on the arteries of the thorax and abdomen, and is extremely delicate on those of the brain: on the contrary, it is particularly strong on arteries that are much exposed to external injury, as in the limbs.

with the lining membrane of the heart. It is a dense, brittle, inelastic, semi-transparent membrane, not presenting any appearance of fibres: neither vessels nor nerves can be traced into it; but their presence can be inferred from their morbid affections, and the results of experiments. In some of the larger vessels, as the arteries, we frequently find the calibre of the vessel reduced, and the lining membrane consequently thrown into longitudinal folds: on the contrary, at the bend of the elbow and knee, we find transverse folds in the lining membrane of the humeral and popliteal: the same appearance has been observed in the coats of arteries that have retracted, as after amputation. In the aorta, it is sufficiently thick to be divided, without much difficulty, into several layers, — the deeper layers having less density and transparency than the layer that forms the free surface of it.

*The middle coat* is much thicker than either the external or internal. It has a buff colour, is distinctly fibrous, and formed of "*yellow tissue*" analogous to the substance composing the ligamenta subflava. The fibres take a direction almost transversely*, and each of them forms a large segment of a circle, but never a complete one. It is owing to the firmness of this coat that an artery preserves its circular form when empty. According to Hunter, a transverse section of the middle coat presents the appearance of two concentric rings; — in the external, or lighter, resides the elasticity of the coat; and in the internal, or darker, resides its muscularity. In the large vessels he found the pale substance most abundant, and the dark substance in the smaller. It is certain that the large arteries are more elastic than the small ones; and as for muscularity, this is a point will require more particular consideration.

Before we proceed to inquire whether the middle coat of an artery is contractile or not, it will be necessary to define exactly the kind of contractility we mean — for there are several kinds. — 1. A part may contract under the influence of chemical agents: thus, a quill or piece of leather contracts when held in the flame of a candle. This Bichat terms *crispation*: — 2. A part may con-

* Mr. Hunter supposed that they must necessarily be spiral, as a circular fibre would not allow of the arteries contracting to so great a degree as they have been observed to do.

tract by its *elasticity* :— 3. Animal matter may possess *tonicity*, or contractility of tissue: thus, if the muscles of one side of the face be paralysed, those of the opposite side, meeting no resistance, *gradually* contract to a degree that they never would if antagonised: — 4. There is *organic contractility*; which is either *sensible* — as when we see a muscle smartly contract under the influence of an irritant; or *insensible* — as in cases in which we cannot see, but may infer, such motion *: and, lastly, there may be *animal contractility* — as where a muscle contracts under the influence of the will, or under irritation communicated through the nervous system. Now, the question is, Do the middle coats of an artery possess sensible organic contractility? Will they contract immediately on the application of an irritant?

When we consider the normal structure in the lower order of animals, who possess pulsating vessels, and yet are devoid of true hearts, and the occasional deviations from the normal structure in certain acephalous fœtuses, who also appear deprived of hearts, we certainly find a presumption in favour of the muscularity of the arteries; — but, on a more particular inquiry, we find the analogy does not hold good. Let us take, for instance, the acephalous fœtus.† Here we are told the heart is absent; but those that are well informed in embryology know that the rudimental heart of the fœtus is an elongated muscular tube; and that in acephalous fœtuses, therefore, it is the form of the adult heart that is wanting, and not the heart itself.

Again; the dorsal vessel that has been observed pulsating in insects, is not one analogous to an artery in man, but is in fact an elongated heart.

Another analogical argument in favour of the muscularity of the arteries has been derived from the circulation in fishes (see *woodcut*, p. xvii.); in which, as I have already pointed out, the whole capillary system of the lungs is interposed between the heart and aorta. This argument, I confess, had great weight with me till I read M. Pouseuille's experiments.

This physiologist provided himself with the graduated bent glass,

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* Bichat sometimes uses this term in a very different and a very vague sense.

† For instances of this kind see Brodie, *Phil. Trans.* for 1809, and Hewson, *Exp. Enq.* vol. ii. p. 15.

already described at page xxix., and on applying it to various sized arteries in the same animal, he found that on each pulse of the heart the mercury was raised in each case to exactly the same height; indicating clearly that the blood was moved in each artery with precisely the same degree of force.

My readers, I presume, are not unaware that experiments have been made by Thomson, Phillip, and Hastings, in order to establish the irritability of the arteries. These experiments were skilfully conducted, and no doubt faithfully recorded; are valuable as furnishing a collection of facts, which may hereafter admit of clear explanation in a more advanced state of our knowledge; but I think they are utterly inadequate to prove the irritability of the arteries. I have many reasons for this conclusion; but I shall content myself with naming one, because I think it a sufficient one; namely, that the contraction of the vessels did not occur immediately on application of stimulants; but that, on the contrary, an interval, sometimes of several minutes, occurred between the contraction of the vessel and the application of the irritant. I also object to those experiments, in which chemical stimuli are employed, that are capable of producing a puckering or crispation of the vessels: such are experiments with sulphuric and nitrous acids, &c. In such experiments I put no faith — and when those which are objectionable have been struck out of the list produced by those gentlemen, the rest will be found few, and, in my opinion, insufficient.

Partial determinations, as in *blushing*, *erection*, and *inflammation*, are also referred to as evidence of the muscularity of the arteries. They certainly afford a presumption in its favour, but cannot prove it, inasmuch as these phenomena may be otherwise explained. (See Earle *On Inflammation*, in the *Lon. Med. Gaz.* April 4. 1835, *et seq.*; and *Erection*, in *Müller's Physiology*.)

Mr. Hunter's experiments in favour of the muscularity of the middle coat of the arteries, merely prove that they possess vital contractility; but not that form of it which is termed muscularity. Thus, he cut across the posterior tibial artery of a dog, and found the stream that issued from it *gradually* diminish as the artery contracted, and at length entirely cease. In another experiment he bled a horse to death, in order to make them contract as much as possible during life. When the animal was dead, he cut out a

portion of the aorta, slit it up, and measured its breadth. He next stretched it forcibly, and then allowed it to recover itself; and he found it did not contract to its former limit. From which he argues that its state of contraction when first measured must have been owing to a vital property, since, after life was destroyed, it was incapable of contracting in the same degree. Now, first, it may be observed, that the proof of vital contractility is not a proof of muscularity; and, secondly, even this property is not proved by experiment: for if an artery were made of Indian rubber, it would produce the same phenomena, if similarly treated.

It has been said that the *bulbus aortæ* of fishes and amphibia has been seen to contract after having been removed from the body. Muller admits this; he has seen it himself; but he observes that the bulb is an appendage of the heart, and not a part of the arterial system, and maintains that nothing of the kind was ever observed in an artery. It has been also urged in favour of the muscularity of these vessels, that in corresponding limbs the pulse sometimes differs in strength. This has been observed in cases of paralysis or of inflammation confined to one side, and depends on less or greater obstruction than natural being offered on the diseased side, in consequence of the local affection; and though there may be a difference of strength in these cases, there is never a difference of velocity. In the same way (that is, by obstruction) we explain the weakness of the pulse beyond an aneurismal tumour.¶

*General Appearance and Chemical Composition.*—We find muscular fibres soft and lax, while the fibres of the middle coat of an artery are dry and brittle. We must admit, however, that Mr. Travers, in his experiments on the intestines, found that a ligature drawn tightly round one of them, divided its middle and internal coats, leaving the external undivided as in an artery. Dr. Hodgkin (see the Appendix to his translation of *Edwards on Life*) has observed that the arterial fibres do not present, when examined with a microscope, the transverse striæ which are seen on muscular fibres. Lastly, the fibrin of the blood is soluble in acetic acid, and with difficulty soluble in mineral acids; while the arterial fibre is insoluble in acetic acid, and readily soluble in mineral acids, and its solution is precipitated neither by alkali nor by ferro-cyanuret of potassium, which must happen if it contained fibrin. — (*Muller.*)

We have now examined the various arguments derived from analogy, observation, experiment, and chemical analysis, and we do not find, that either singly or collectively they lead to the conclusion that the arteries are muscular. We have, moreover, shown that the influence of the heart extends through the capillary system, and operates in the venous system, and is therefore perfectly adequate to impel the blood through the arteries; we have also shown that the ventricles are active in their dilatation and therefore exert a sorbent power over the venous blood, as originally suggested by *Wilson*. The influence of respiration on the motion of the blood will be considered hereafter.

It now only remains to observe, that those who maintain the muscularity of the arteries, must also maintain that their contraction is vermicular (that is, uniformly progressive from the heart to the capillaries); for otherwise muscular action would rather tend to retard than promote the progress of the blood.

But while I deny that the arguments above adduced are sufficient to prove the irritability of these vessels, I am not disposed to admit the conclusiveness of several arguments that have been adduced on the opposite side of the question. Thus, Bichat remarks that there is a distinct tendinous ring at the orifice of the aorta and pulmonary artery, separating the muscular fibres of the heart from the middle coat of the artery, and proving the difference of their nature. But let us remember that a similar ring is situate at each of the auriculo-ventricular openings, though the fibres which they separate are clearly muscular; moreover, there is an an obvious necessity for this tendinous ring; for, if the valves in this situation were merely circumscribed by lax, yielding muscular fibres, they would be incapable of closing with the necessary precision.

Again, Bichat informs us that he removed a portion of an artery, and having connected the divided extremities of the vessel by an inert tube, he found the pulse quite distinct on the capillary side of the incision. From this experiment he inferred that the heart *alone* was the cause of the impulse; which is clearly a *non sequitur*.

Lastly, some of the pathological facts on which Bichat relied, have been called in question. Thus, he argued that the circulation through the arteries could not depend on their contraction, as an

ossified state of these vessels is often unaccompanied by any interruption in the circulation; while his opponents support the irritability of the arteries, on the very ground that an ossified state* of the femoral vessels is invariably followed by Pott's gangrene.

It is therefore evident that the question of the muscularity of the arteries is still undecided.

*Cellular Tissue.* — The fibres of the middle coat of an artery are not only united by being interwoven with each other; but, according to the observations and experiments of Professor Hart, of Dublin, by cellular tissue. (See Dr. Todd's *Cyclopædia of Anatomy*, art. ARTERY.)

*Vasa Vasorum.* — The coats of an artery are not supplied by the blood circulating in its interior, but by off-sets from muscular and other contiguous branches.

*Nerves and Absorbents.* — The arteries are surrounded by nerves in the form of sheaths, but none of the filaments can be satisfactorily traced into the coats. Cruveilhier supposes that these nerves are destined not for the vessel, but for the organ it supplies. However, the phenomena of disease leave no doubt whatever that arteries possess both nerves and absorbents.

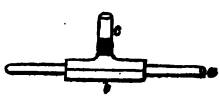
*Form of the Arteries.* — Some arteries appear to have a cylindrical form; while others, as the spermatic, obviously increase in capacity as they advance. It appears, however, from the recent researches of Bizot, that arteries have various other forms in different parts of their course. The following forms were observed in 2162 examinations.

| | |
|---|---|
| Cone with base to the heart - - - | 858 |
| Truncated cones opposed at their summits - | 610 |
| Cone with summit to the heart - - - | 319 |
| Cylindrical - - - - - - | 248 |
| Cones with bases opposed - - - - | 127 |
| | 2162 |

* I have dissected the bodies of several patients that died of Pott's gangrene, and in *every instance* I found the arteries of the lower extremities more or less ossified.

As the popliteal artery assumes this last form, it may be a reason of aneurism so frequently occurring in this vessel.

*The Arterial Pulse.* — If a ligature be placed on an artery, no pulse is felt beyond the obstructed part, though it is clearly felt on the cardiac side of the ligature: hence it is evident that the pulse does not depend on the action of the artery, but on the impulse of the jet of fresh blood from the ventricle. If a curved artery be exposed in the living body, it obviously elongates itself at each pulse, as every operating surgeon must have observed. Muller distinctly noticed this effect in the pulmonary artery of a frog. A pulsating artery is also increased in its transverse measurement; and Pouseille has invented an ingenious instrument, represented in accompanying *figure*, for measuring the exact extent of its dilatation. The instrument consists of a short cylinder (*b*) of white metal, open on one side so as to allow it to be put round an exposed artery (*a*). The open side of the cylinder is then closed with another plate, from which arises, at right angles, a glass tube (*c*). At each extremity of the instrument, the interval between the cylinder and coat of the artery is closed with lard, which prevents the escape of the water which is introduced within the cylinder, and the ascent of which in the glass tube marks the degree of distension of the artery at each pulse.



The dilatation is much less in degree than the elongation, and is in some cases very obscure. In an instance of this kind, in which it was indistinct in the crural artery of an animal, Magendie made it apparent by applying a ligature round the vessel. This had the effect of causing its gradual contraction on the distal side of the obstruction. On removing the ligature, the vessel gradually recovered its original calibre; and during this time the dilatation was extremely obvious at every pulse. It therefore appears that a pulsating artery is both elongated and distended, and that its pulse depends on the impulse communicated from the ventricle. From the above account it is also obvious that the pulse must be later in the vessels distant from the heart, than in those that are in its more immediate vicinity. If the arteries had been indistensible tubes, the pulse in all of them would have been synchronous with that of the heart, as supposed by Bichat.

The frequency of the heart's action varies at different periods of life, as shown in the following table*:—

| | |
|---|---|
| In the embryo it is | 150 |
| Just after birth | 130 to 150 |
| During the first year | 115 — 130 |
| During the second year | 100 — 115 |
| During the third year | 90 — 100 |
| About the seventh year | 85 — 90 |
| About the fourteenth year | 80 — 85 |
| In the middle period of life | 70 — 75 |
| In old age | 50 — 65 |

The next table shows its comparative frequency in different animals: —

| | |
|---|---|
| In the fish it beats in a minute | 20 to 24 |
| In the frog | 60 |
| In birds | 100 — 140 |
| In the bat | 200 |
| In rabbits | 120 |
| In the cat | 110 |
| In the dog | 95 |
| In the sheep | 75 |
| In the horse | 40 |

*The tonicity of the arteries*, demonstrated in Mr. Hunter's experiments, is the cause of these vessels being found empty after death, and of their contracting in the living subject on being exposed to the air; and the skin, and several other structures that no one ever thought of calling muscular, are endowed with similar properties.

Independently of their vital properties, arteries may contract by virtue of their elasticity.†

* Dr. Macdonnell, of Belfast, read a very interesting paper at the meeting of the British Association in Dublin, showing the decided influence which the position of the body has on the rate of the pulse. In the vertical position of the body it is more rapid than in the horizontal.

† The distinctions between elasticity and muscularity are sufficiently clear, though these properties are sometimes confounded

*The elasticity of an artery* is exerted in the retraction after amputation, and in converting the flow of blood from an intermittent into a continuous stream. This requires a little explanation. If a large artery be wounded, the blood flows in jets; if a smaller artery be wounded, this appearance is less distinct; and if a minute artery be wounded, the blood flows in a continuous stream. This is in accordance with a law well known to natural philosophers, namely, that an intermittent stream may be rendered continuous, by employing the force which produced it, to compress a spring or rebound, the reaction of which is constant. I shall endeavour to illustrate this in a familiar manner. Let us suppose a common syringe, to the extremity of which is affixed an elastic bag or tube. The syringe is worked by intermittent strokes. When the piston descends, the fluid is forced through the elastic tube, *the sides of which are at the same time stretched or distended:* when the piston is withdrawn, a valve prevents the fluid from regurgitating into the syringe; and the distended tube, contracting by virtue of its elasticity, forces the fluid on: so that the fluid is continually progressing; being at one time impelled by the advance of the piston, and during its retreat by the elasticity of the distended tube. It is on a similar principle the common fire-engine is constructed.

### III. The Veins.

Almost every artery is accompanied* by one or more veins; whereas several veins, particularly those that are subcutaneous, have no corresponding artery: hence it follows that the veins are more numerous than the arteries. They are also, in general, of

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by authors. Thus: muscularity may begin action; elasticity can only restore a part already moved. Muscularity can only move in one direction, elasticity can move successively in opposite ones. Elasticity is obviously proportioned to its cause; muscularity, on the contrary, may produce violent action, while the cause is apparently trifling. Muscularity never survives the life of the part; elasticity remains till disorganisation sets in. Muscularity may be exhausted and restored by rest; elasticity never can.

* There are, however, some exceptions to this: thus, the two dorsal arteries of the penis have a common vein.

greater calibre; therefore the venous system has greater capacity than the arterial*; and will, consequently, transmit the blood with less rapidity.

The venous system has an arborescent form, consisting of a number of branches which terminate in the capillaries, and of a few trunks which terminate in the heart. The branches are necessarily smaller than the trunks, but collectively they have greater capacity, and therefore the velocity of the blood contained in the veins will increase as it approaches the heart.

*Structure of the Veins.*

The veins consist of two coats only, except in the immediate neighbourhood of the heart, the muscular fibres of which may be distinctly traced into the venæ cavæ and pulmonary veins.—The *external coat* is formed of condensed cellular tissue, and is by no means so essential as the internal, since it is deficient, and its place supplied by other tissues in different parts of the body, as in the bones, the sinuses, and the corpus cavernosum penis. The *internal coat* is continuous with the endocardium, or lining membrane of the heart, and analogous to the lining membrane of the arteries. Magendie, however, states that it is by no means so brittle, as it is not divided by a ligature drawn tightly round the vessel. Between these two coats, an intermediate one, consisting of longitudinal fibres, has been described; but, as we have already observed, it is only found in the large vessels. The veins are supplied with blood-vessels, absorbents, and nerves. The nerves do not, however, form plexuses around them, as they do round the arteries, except in the system of the vena portæ. The parietes of the veins are much thinner than those of the arteries†, and therefore they collapse when they are empty. Their thickness is absolutely greater

* According to Haller, the capacity of the veins to the arteries is as 2 to 1; according to Borelli, as 4 to 1; and according to Sauvages, as 9 to 4.

† According to Haller, the proportion between the area of the inferior cava and aorta is as 16 to 9; and the thickness of their coats, according to Wintringham, as 1 to 15. The inferior cava supported a weight of 176 lb., while the aorta burst under the pressure of 138 lb. 11 oz.

in the large veins than in the small ones, but they are thinner in proportion to their calibre. Their thickness varies in different situations: thus, the internal veins are thin, while the coats of the subcutaneous veins are nearly as thick as those of an artery.

The *valves* are formed by duplicatures of the lining membrane. Each of them has a semilunar or parabolical form. One margin is convex, and attached to the interior of the vessel; the other is free, concave, and directed towards the heart. Both its surfaces are free; one looks towards the internal wall of the vein, and the other towards its axis. In addition to the two layers that form each valve, we find an intermediate tendinous structure, from which it probably receives its great power of resistance. Some veins are entirely devoid of them. Thus, we find none in the cerebral or pulmonary veins, nor in the superior cava, inferior cava, internal jugular vein, vena portæ, nor in any vein having a smaller diameter than a line. They are more numerous in those in which the blood moves against gravity, than in those differently circumstanced; and in the superficial veins of the limb, than in the deep ones. Sometimes a valve is solitary; more frequently they are in pairs; in many situations we find three, or even four. Their use is obvious: they direct the current of blood towards the heart, and prevent its returning in the opposite direction.

### *Properties of Veins.*

The veins are endowed with sensibility and contractility. Their sensibility is proved by the effects of inflammation; but is not developed by ligature or irritation, when they are sound. Veins possess no muscular contractility, except in the immediate neighbourhood of the heart; but in every part of the system they possess tonicity, or contractility of tissue. There are, perhaps, no vessels capable of greater extension in the transverse direction, though they allow of but little in the longitudinal. Bichat observes, that an artery can be dilated to twice, and a vein to five times, its natural size, without breaking. Lastly, veins possess elasticity, though by no means in so marked a degree as the arteries.

### *Causes of the Venous Circulation.*

We have already seen that Poiseuille has proved that the influence of the heart's contraction extends to the venous system.

We have found, in like manner, that the heart is active in its dilatation, and therefore exerts a sorbent power.* It is, moreover, generally admitted, that, in consequence of the arrangement of the valves, the pressure of surrounding bodies must determine the progress of their contents towards the heart. We have now to add the influence of respiration; the most distinguished advocates of which are Dr. Carson, of Liverpool, and Sir David Barry.

*According to Dr. Carson*, the lungs are highly elastic, and have a constant tendency to collapse. This produces a constant tendency to a vacuum in the pericardium and heart; and in order to fill it, the blood is drawn from the veins.

*According to Barry*, a vacuum is formed in the chest during inspiration; all surrounding fluids must, therefore, endeavour to enter and fill it. Accordingly the atmospheric air rushes into the lungs; and moreover, by its pressure on the veins of the body, propels their contents towards the large veins of the thorax. But in consequence of a vacuum being produced in the pericardium at each contraction of the heart, the blood from the venous trunks are necessarily directed towards the auricles.

Although, in both these theories, there are points of a very questionable nature assumed as certain, yet there can be no doubt of the truth of the general principle advocated — namely, that the transmission of venous blood to the heart is aided by inspiration. It is not, however, a principal, but a secondary agent:

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* The following experiment, performed by Wedemeyer and Guenther, seems decisive on this point. They tied the jugular vein of a horse, and then opened the vessel on the cardiac side of the ligature, and introduced a catheter. To the extremity of the catheter was cemented a bent glass tube, the longer or descending ramus of which was placed in a vessel of coloured water. At first the inspirations and pulses of the heart were simultaneous, and at each inspiration the water rose in the tube, and then subsided to its previous level. After some time the inspirations became twice as frequent as the pulsations, and now the ascent of the water in the glass tube corresponded, not with the inspirations, but with the contraction of the heart,— that is, with the dilatation of its auricles — clearly proving the sorbent power of the heart.

and it should be remembered that there are no motions of respiration in the fœtus, in fishes or in frogs (the last of which take in air by a kind of deglutition); and yet in these animals the circulation is as accurately performed as in the human adult.

*Venous Pulse.* — The veins have been observed pulsating under the following circumstances:— 1st, In consequence of regurgitation from the heart. It may be remembered that there are no valves at the orifices of the cavæ or pulmonary veins; and therefore, during the contraction of the auricles, a portion of their blood is thrown back into the large vessels. This effect is often observable in the jugular vein of the living subject; and Muller and others have seen it in the pulmonary veins and inferior cava of inferior animals. Haller has observed it extend to the iliac vessels. — 2dly, Veins may have a pulsation communicated to them from a subjacent artery. — 3dly, The influence of the heart may extend so forcibly through the capillaries, as to cause a pulse in the entire of the venous system. A case of this kind was published a few years since by Dr. Davis, of Dublin.—Lastly, In some animals there are special propulsive cavities on certain veins. They are then termed hearts. Of this kind is the caudal heart of the eel described by Dr. Marshall Hall.

## IV. The Capillaries.

The capillaries are the next parts of the circulating system that claim our attention.

According to the opinion that has been very generally received, the blood may be transmitted from an artery to a vein, either by a capillary sufficiently large to give passage to its red globule, or so small as to transmit its serous portion only, and according to their capacity they are termed either the *vasa rubra* or the *vasa non rubra*. The latter vessels have also been termed *serous vessels*.

There are strong grounds, however, for doubting the existence of vessels that are incapable of carrying the red globules. Muller has distinctly observed, with a microscope, a single line of red particles flowing through a capillary vessel that seemed perfectly transparent to unassisted vision. The capillaries are the minutest tubes, without exception, in the body, — varying in diameter from $\frac{1}{1000}$ to $\frac{1}{3000}$ of an inch: their meshes vary in size in different parts of the body. In children, the capillaries are larger

i proportion than in adults. In the brain they are very minute, and comparatively few in number; so that the blood must therefore pass through this organ with the greater velocity. They probably exist in every part of the body, though in some they have not yet been observed. In form they differ from the small arteries and veins, in not gradually diminishing or increasing, but presenting an uniform size in their course from the artery to the vein. The meshes in which they are arranged, differ in form and density; thus, the meshes may be more or less elongated, or the capillaries that form them may be more or less approximated. Generally speaking, they are separated in the human subject by intervals equal to their own calibre.

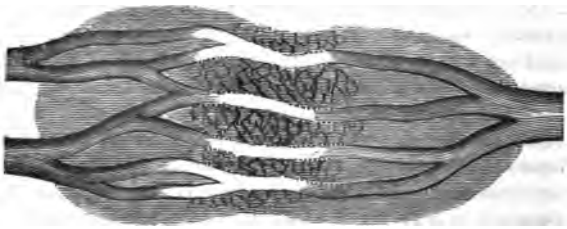
Though numerous observations have been made on the capillaries, yet authors are by no means agreed as to their structure.

*Dr. Marshall Hall*, in his *Essay on the Circulation of the Blood*, describes the capillaries as a network of transparent vessels, differing from the small arteries in the circumstance that they subdivide without becoming smaller. He describes them as minutely anastomosing with each other, like nervous plexuses, and forming thus an intermediate system between the small arteries and veins. He supposes these vessels to be passive; and their contents to be propelled, partly by the action of the small arteries, which he believes to be muscular, partly by capillary attraction, and partly by the suction of the veins. (See *woodcut.**) Among the latest and most authentic observations made on the capillaries, are those of —

*Dr. Wedemeyer.*—According to this writer, both the middle and inner coat of an artery decrease in thickness in proportion as the vessel diminishes in size; and at length both terminate gradually in membranous canals formed in the substance of the tissues; so that

* This woodcut is copied from Dr. Baly's translation of Muller; and Dr. Baly reduced it from an engraving in Dr. Todd's *Cyclopædia*.

the blood no longer flows through actual vessels, but through furrows, or canals, whose walls are the surrounding parenchymatous



tissue. (See *woodcut.*) These opinions are principally founded on microscopical observations. Wedemeyer does not mean to assert, however, that the entire of the blood passes through these membraneless canals; for, on the contrary, in different animals, and in a great number of instances, he has seen the blood passing through real vessels continuous from the arteries to the veins.

*Causes of the Circulation through the Capillaries.*

The first cause I have to notice, is the supposed muscularity of their coats. The question of the muscularity of the arteries, both great and small, has been already fully considered; and I think I have shown there is no satisfactory evidence that they possess this property. The attraction of the capillaries is another assigned cause: this property, no doubt, exists to a certain degree; but its effects must be, unless overcome by other powers, rather to cause an accumulation in these vessels, than to propel their contents. Thirdly, the pressure of surrounding parts can only empty the portion of the vessel compressed; and therefore, according to circumstances, the fluid in the capillary may either advance or retrograde, or escape by collateral channels,—in fact, it will flow where there is least resistance. The sorbent power of the heart has been already considered, and its influence admitted (Note, p. lvii.). But the principal power that moves the blood through the capillary vessels, is, unquestionably, the contraction of the ventricles. In an animal that is much exhausted, the heart acts with less force; the vessels are less distended beyond their medium state; their elasticity, which renders continuous the stream in the small vessels, is less brought into play. In such cases, the influence of the

heart on the blood in the capillaries has been most distinctly observed.

In fishes, the capillary system of the lungs is interposed between the heart and aorta. In some instances, in the human subject, the pulsation of the heart has been distinctly felt extending over the whole venous system. (A case of this kind has been already noticed.) The spontaneous movement of the blood is an hypothesis of modern days. Those who wish to see this hypothesis ably refuted, should consult Magendie's lectures, now in course of publication in *The Lancet*. Lastly, there is a principle of motion that has been lately announced by Dutrochet, and which is now supposed to have considerable influence over the circulation in the capillary system, and in the vesicles of vegetables. It has been observed, that if two fluids of different densities be separated from each other by a thin bladder, a mutual attraction takes place, in consequence of which a double current is established through the bladder, in opposite directions, and of different strength, causing a greater accumulation on one side of the bladder than on the other. Dutrochet has proved by experiment, that similar currents take place in the vesicles of vegetables; and experiments have been made both in America and this country, to prove that this property exerts a considerable influence over the circulation of the fluids in the extreme arteries. Both sides of the question, however, should be fairly considered. *Endosmosis* is explained and defended by Dutrochet, in Dr. Todd's *Cyclopædia*; and it is formidably opposed in Raspail's admirable and unique work on organic Chemistry.

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We have now considered the structure and mechanism of the various parts composing the circulating system, and have only to add, that if we reckon the whole mass of the blood at 33 lb., and suppose the heart to expel 2 oz. at each contraction, and that there are 75 contractions in a minute, it will follow that the whole of the blood shall have passed through the heart in about 2½ minutes, or 24 times in an hour.

## Descriptive Anatomy of the Heart.

In order to expose the heart, it will be necessary to cut through the pericardium (or membrane which incloses it) — a previous description of which will therefore be required.

### *The Pericardium*

Is a fibro-serous bag, inclosing the heart and commencement of the large vessels that issue from it. Its form is that of a cone, the *apex* of which corresponds to the large vessels over which its fibrous or exterior coat is lost, opposite the entrance of the vena azygos into the superior cava. The base rests on the tendon of the diaphragm, to which it adheres firmly, and also on the left muscle of the diaphragm, to which its adhesion is less intimate. In the fœtus, indeed, it may be readily dissected from both.

The sides of the pericardium are connected to the pleura, the phrenic nerve being interposed on the left side. The posterior surface rests on the œsophagus and descending aorta, while the anterior surface is covered by the thymus gland, sternum, and lungs. By cutting into the front of the pericardium, we expose the internal or serous layer, which consists of two portions; one of them lines the interior of the fibrous layer, while the other embraces the heart. These two portions are connected and rendered continuous, first by a perfect cylindrical sheath, which incloses within it both the aorta and pulmonary artery; and, secondly, by imperfect sheaths or processes of the membrane, which

cover (without entirely embracing) the two venæ cavæ and four pulmonary veins. These two portions of the serous layer, taken together, constitute a completely shut sac, so that the vessels going to or issuing from the heart do not pierce, but are only covered by it.

The parts exposed by opening the pericardium are the superior surface of the heart, the two venæ cavæ, the aorta, the pulmonary artery, and the right auricular appendix, and tip of the left auricular appendix. The left auricle is concealed by the large vessels.

### *General Description of the Heart.*

The heart is a muscular bag of a somewhat conical form, and consists of four chambers united into an individual mass: two of these are the auricles, and the remaining two the ventricles. *The Apex* of the heart is formed (in the adult) by the extremity of the left ventricle; and looks downwards, forwards, and to the left side, towards the interval between the fifth and sixth ribs. In many subjects it is curved a little backwards. *The Base* is turned upwards, backwards, and to the right side. *The inferior Surface* is flat and triangular, and the *superior Surface* convex and more extensive. These surfaces are separated by two margins. *The anterior Margin* is thin, and looks downwards, forwards, and to the right side. *The posterior Margin*, which is shorter but considerably thicker, looks in the opposite direction.

The chief bulk of the heart is formed by the ventricles, particularly the left; and the auricles seem like appendices situated at its base.

### *External Appearance of The Auricles considered as an Individual Mass.*

The auricles are situated at the posterior part of the base of the ventricles, and form a crescentic mass, *one of the surfaces* of which is concave, looks upwards and forwards, and embraces the aorta and pulmonary artery: this surface forms about three fourths of a circle, and lies in a plane far behind the anterior surface of the ventricles. The *opposite surface* looks downwards and backwards. It is convex, and continuous with the inferior surface of the ventricles: it presents, moreover, a groove, corresponding to the septum of the auricles, and continuous with a longitudinal groove on the inferior surface of the ventricles. At the right side of the groove we observe the entrance of the inferior cava, and lower down that of the coronary vein. *A third surface* of the auricular mass looks downward and forward, and is united to the base of the ventricles, with which it communicates by the auriculo-ventricular openings. The *remaining surface* looks upwards and backwards. It forms the highest part of the heart, and presents the continuation of the groove corresponding to the septum of the auricles. On the left side of the groove it presents the orifices of the pulmonary veins, and on its right side the opening of the superior cava. Lastly, the right and left extremities of this crescentic mass advance on either side, embracing the aorta and pulmonary artery, and constituting the appendices of the auricles.

### *External Appearance of The Ventricles, considered as an Individual Mass.*

The ventricles form a conical mass, the apex of which looks downwards, forwards, and to the left side; the base upwards, backwards, and to the right side.

*The Superior Surface* of this mass is convex, and presents a fissure which runs from the base to the right side of the apex. It lodges the anterior coronary artery, and divides the anterior surface into a right and left portion. The left portion is formed by the anterior surface of the left ventricle; and the right portion, considerably more extensive, is formed by the anterior surface of the right ventricle.

*The Inferior Surface* of the ventricular mass, less extensive than the superior, is plane, and rests on the superior surface of the diaphragm. A fissure, running from the base to the right side of the apex, and lodging the coronary vein and posterior coronary artery, divides this surface into unequal portions; the more extensive of which belongs to the left ventricle, and the remainder to the right.

*The Anterior Margin* of this mass is thin, and longer than the posterior.

*The Posterior Margin* is thick and convex, and is lodged in a depression of the left lung.

*Its Apex* is formed in the adult entirely by the left ventricle, and

*The Base* presents for examination the following appearances: — First, in front, a funnel-shaped projection of the right ventricle upwards, termed the

*infundibulum*, from which arises the pulmonary artery. On a posterior plane, concealed by the infundibulum, and more to the right side than the orifice of the pulmonary artery, is the origin of the aorta from the base of the left ventricle. Behind these two orifices the base of the ventricular mass presents a circular fissure, circumscribing the portion of it which corresponds to the auricles. This fissure is very deep posteriorly, a part of the inferior surface of the ventricles dipping forwards to be applied to a corresponding free surface of the auricular mass. Lastly, the base of the ventricular mass is cut obliquely downwards and backwards at the expense of the inferior surface, which is consequently shorter than the superior.

Having thus described the external appearance of the heart, we may now proceed to consider individually its chambers, which are, as already observed, four in number; viz. two auricles and two ventricles.

### *The Right Auricle.*

Has the form of the quarter of an ovoid divided by a St. Andrew's Cross; and will consequently present for examination three walls and two extremities.

*The External Wall* is easily defined, as it is formed by all that portion of the right auricle that can be seen without cutting into its interior: it is therefore convex, and applied externally to the pericardium. It presents several dark lines corresponding to the interval between the musculi pectinati to be described lower down.

In order to see the internal surface of this wall,

we should make two incisions; one in a vertical direction through the front of the auricle, connecting the orifices of the superior and inferior cava: the other is to take a horizontal direction, commencing beneath the right auricular appendix, and terminating in the superior extremity of the preceding incision. In this manner a triangular flap will be formed out of the external wall of the auricle. You have now an opportunity of examining the structure of this wall. You see that its muscular fibres are arranged in fasciculi, like the teeth of a comb *: they are consequently termed *musculi pectinati*. In the intervals between these fasciculi, the auricle is only formed by the lining and investing membrane, which are here in immediate apposition. Lastly, a tubercle has been described as projecting from this outer wall into the auricle: it is termed the *Tuberculum Loweri*. If we remember that the superior cava passes downwards and to the left, and the inferior cava upwards and to the left, we can readily understand that the portion of the auricle between their orifices must of necessity be salient: this constitutes the tubercle. The use ascribed to it is to direct the blood towards the centre of the auricle, and prevent the currents from the superior and inferior cava from directly opposing each other.

*The Internal Wall* is the septum between the two auricles; its right surface, which we are now examining, looks also a little forwards. In its lower part it pre-

* The comparison is not quite correct, as the musculi pectinati are connected by oblique bands.

sents a remarkable oval depression, termed *the fossa ovalis*. This fossa is bounded by two pillars; one posterior and to the right—the other anterior and to the left. The anterior is much stronger than the posterior; it separates the fossa ovalis from the opening of the coronary vein, and gives attachment to the great Eustachian valve. These two pillars are continuous, superiorly, so as to form a kind of arch over the fossa ovalis. At the lower part of the fossa, and between its pillars, may be observed a valve projecting into the left auricle, and closing the fossa. Before the second month of intra-uterine life, this valve does not exist. At the end of the second month, it makes its first appearance; and at the seventh month, its superior margin, which is concave*, ascends sufficiently high to close the aperture: there is then an oblique passage instead of a direct communication between the two auricles. In the adult, the foramen is usually, but not invariably, closed by the adherence of the upper edge of the valve. Connected with the anterior pillar of the fossa ovalis, may be observed *the great Eustachian valve*. This valve has a crescentic form: its superior horn is attached to the anterior pillar of the fossa ovalis: its inferior horn is first united to the left margin of the orifice of the inferior cava; and then sends an expansion in front of this opening towards its right margin. Of the two margins of the valve, one is concave and free, and looks towards the right shoulder; the other is convex, attached to

* See St. Ange's description, page xxxv.

the auricle, and looks in the opposite direction. Superiorly this valve separates the fossa ovalis from the orifice of the coronary vein, and inferiorly it separates the orifices of the coronary vein and inferior cava. The great Eustachian valve is large in proportion in the young fœtus, but gradually diminishes as the valve of the foramen ovale increases. *The lesser Eustachian valve* is a small duplicature of the lining membrane; it arises in the lower extremity of the greater Eustachian valve, and, separating from it as it descends, turns round the orifice of the coronary vein, of which it is the valve.

*The Anterior Wall* of the auricle looks towards the right ventricle, *i. e.* downwards and forwards. It presents the auriculo-ventricular opening, the long axis of which is directed from before backwards.

*The Superior Extremity* of the right auricle presents the right auricular appendix, and the opening of the superior cava. *The right auricular Appendix* is triangular in its form, and situate between the aorta and right ventricle. Its base is continuous with the auricle, without any line of demarcation. Its apex is turned transversely towards the left side: posteriorly it is concave, and embraces the aorta; and anteriorly it corresponds to the pericardium. Its interior is irregular like the inner surface of the auricle.

The superior cava takes a direction downwards, forwards, and to the left side. Its orifice is situated in a plane anterior to that of the inferior cava, and its aspect is downwards and backwards. Two prominent muscular bands bound this opening: one of

them separates it from the orifice of the inferior cava; the other, not so well marked, is situated on the left side, and separates the orifice of the vein from the auricular appendix.

*The Inferior Extremity* of the right auricle presents the orifices of the inferior cava and coronary vein. The inferior cava, in approaching the heart, takes a direction upwards, backwards, and to the left side. At first it ascends almost perpendicularly; and then affecting a more horizontal direction, turns abruptly into the auricle, immediately before which it frequently presents a dilatation. Its orifice is larger than that of the superior cava, and is situated in a posterior plane: it likewise differs from it in its relation to the Eustachian valve.

A number of minute openings on the surface of the auricle are termed *venæ Thebesianæ*. See Appendix.

### *The Left Auricle.*

*Exterior of the Left Auricle.* — The left auricle has somewhat the form of a four-sided pyramid; *the Base* of which is the septum auricularum, while the sides converge * externally to be continuous with each other. *The anterior Wall* looks also somewhat downwards; it corresponds to the left ventricle, and presents the left auriculo-ventricular opening. *The posterior Wall* looks a little upwards, and receives the four pulmonary veins. *The superior Wall* looks also forwards; it gives off the auricular appendix, behind which crosses

* Some writers describe an external wall, and therefore assign to the auricle a cuboid form. If the student will take an *injected* heart and paint with different colours the superior, posterior, and inferior walls, he will find there will be nothing left for an external wall.

the left pulmonary artery. Lastly, *the inferior Wall* is smooth, and forms with the posterior wall a continuous convex surface, which corresponds (with the interposition of the pericardium) to the œsophagus and descending aorta.

*Interior of the Left Auricle.* — In order to see the interior of the left auricle, an incision should be made vertically through its posterior and superior walls, so as to separate the pulmonary veins of the right and left sides. We now observe that the septum of the auricle is convex towards the right side. In the fœtus it presents the fossa ovalis and valve already described (p. lxviii.); but in the adult there is usually no trace of it. The auriculo-ventricular opening in its anterior wall is smaller than that on the right side, and its long axis is directed transversely. The superior wall presents the orifice of the auricular appendix, which is much smoother internally than that on the left side: and lastly, the posterior wall receives the four pulmonary veins, the orifices of which are unprovided with valves. Sometimes two of the same side have a common opening; but when there are four, the two inferior veins have the larger openings, and the two left veins are nearer than the two right. From the above account it appears that there are seven openings into the left auricle in the fœtus, and six in the adult.

### *The Right Ventricle*

Has the form of a cone, one side of which has been hollowed out to accommodate the convexity of the left ventricle. Its apex is turned in the same direction as the apex of the heart; but, in the adult, does not ex-

tend so low. Its base presents, anteriorly, a pouch, (*the Infundibulum*), continuous with the pulmonary artery; and, posteriorly, an opening into the right auricle; between these two openings it corresponds to the commencement of the aorta. In order to expose its interior, an incision should be made into it in the direction of the axis of the heart, and close to the septum ventriculorum.

The irregularity of the internal surface of the right ventricle is produced by a number of muscular masses, termed the *carneæ columnæ*. There are three orders of these. Those of the first order are attached by both extremities, and by one side, to the ventricle; those of the second order are attached by their two extremities; those of the third order are attached by only one extremity to the ventricle, the other being connected, through the medium of tendinous cords (*chordæ tendineæ*), to the valves of the auriculo-ventricular opening. The two first orders are supposed to be for the purpose of mixing the blood more completely; but those of the third order, contracting at the same time with the ventricle, prevent the blood from forcing the valves into the auricle. The right auriculo-ventricular opening is seen at the base of the ventricle, behind and to the right of the orifice of the pulmonary artery. It is circular when the blood is passing through, but elliptical at other times. Surrounding this opening are seen three triangular laminæ, that constitute the *tricuspid valve*. To these the chordæ tendineæ are attached, on their margins and ventricular surfaces: they prevent the blood from returning into he auricle, when the ventricle contracts to expel it

into the pulmonary artery. By *the tendinous zone* is meant the whitish ring that bounds the auriculo-ventricular opening. As there is a similar one on the left side, we shall consider both at the same time.

### *The Left Ventricle*

Has also a conical form. Its apex constitutes, in the adult, the apex of the heart; and its base has an arterial and auricular opening. The interior of the left ventricle may be exposed by an incision similar to that recommended for exposing the right. The arterial opening (thus exposed) is in front of the auriculo-ventricular, and more to the right side. (See p. lxvi.)

The auriculo-ventricular opening is guarded by two laminæ, that constitute the *mitral valve. The anterior* lamina of this valve has been termed the *Septum of Lieutaud:* that anatomist supposed that it was applied to the orifice of the aorta, while the ventricle was filling. This appears possible, as the aortic opening is in front of the auriculo-ventricular, and only the thickness of the valve distant from it. But it is impossible that the anterior lamina of the *tricuspid valve* could have a similar office (as was supposed), as there is a full inch between the opening of the pulmonary artery and right auriculo-ventricular opening.

The *tendinous zones* are composed of pale tendinous fibres; they have the same form as the auriculo-ventricular openings, which they bound; and they send in productions between the laminæ composing the

mitral and tricuspid valves, which add considerably to their strength. All the muscular fibres of the heart arise from one or other of them; and the endocardium, or lining membrane, is thicker where it covers them than in other situations.

### *Opinions of Bouillaud.*

*According to Bouillaud*, the cavity of each ventricle is composed of two very distinct regions,—one communicating with the corresponding auricle, and the other with the artery arising from its base; and these two portions are not constituted exactly alike in the right and left sides.

*In the right ventricle* the arterial portion is united with the auricular portion, by means of an angle projecting into the ventricle, and the sinus of which is consequently turned upwards [and embraces the aorta].

*In the left ventricle* the arterial and auricular regions are nearly parallel to each other, — not exactly so however — for, on account of the conical form of the ventricle, they approach one another as they proceed from the base to the apex of this cavity. They are separated by the right or anterior lamina of the bicuspid valve, and by two large fleshy columns, which go to be inserted there by means of numerous tendons. Inferior, posterior, and external to this septum, is the auricular region of the ventricle; and superior, anterior, and internal to it, is the arterial or aortic portion. These two regions communicate with each other freely at the interval between the two large columns above mentioned. It is in the auricular region of the ven-

tricle that we principally find the fleshy columns; in fact, a large portion of the arterial region is altogether destitute of them; and the same remark will apply to the right ventricle: those that are found here are small and interlaced, and are not, like the large ones, inserted into the valves. The left ventricle contains fewer carneæ columnæ than the right, but they are more voluminous, and we now proceed to describe them more particularly. Two carneæ columnæ, sometimes as large as the little finger, arise by numerous fasciculi, — the one externally towards the junction of the anterior and posterior walls at the thick margin of the heart; the other arises more internally, near the junction of the posterior wall and septum ventriculi. After having taken root not far from the apex of the heart, they ascend to about half the height of the ventricle, where they become perfectly detached from the wall from which they sprung, and terminate each by a soft rounded extremity, the remarkable and almost constant disposition of which has not been mentioned by any anatomist. The extremity of each column is divided into several fasciculi, which afterwards unite so as to compose but two or three principal bundles, which look towards each other by concave surfaces, so as to form an incomplete circle. One of the two bundles is anterior or superior, and the other posterior or inferior. The posterior bundle is a little shorter and smaller than the corresponding anterior bundle. From the anterior bundle of each column arise several tendons, which go to be inserted in the anterior lamina of the bicuspid valve, which they

approach in diverging like the folds of a fan. From each posterior bundle other tendons arise, which proceed, in diverging, to be inserted into the posterior lamina of the bicuspid valve. In the angles likewise between the laminæ, tendons are inserted, so that the whole circumference of the valve is supplied from the double anterior and posterior terminating bundle of each column.*

## Structure of the Heart.

The heart is essentially composed of muscular fibres, covered on the outside by the serous layer of the pericardium, and on the inside by the endocardium, which is continuous with the lining membrane of the arteries and veins. There also enter its composition, tendon, arteries, veins, nerves, and absorbents. The heart is supposed to possess little or no cellular tissue.

### *The Muscular Fibres of the Heart*

May be traced, first in the ventricles, and afterwards in the auricles.

In order to prepare the heart for examination of its

* In the preceding pages I have ascribed to those carneæ columnæ, that are attached to the valves, merely the office of preventing their retroversion. Bouillaud, however, supposes that they draw the valves from the parietes of the ventricles *towards* its axis previously to their meeting; while Mr. Herbert Mayo maintains that they draw *from* its axis; and to this circumstance he ascribes the accurate closure of the mitral valve, on the principle that, if there be an elliptical opening in any yielding substance, its sides would be approximated by separating the angles. He also states in support of this opinion that Dr. Hope and himself had observed that the ventricles enlarge in the transverse direction during their contraction.

muscular fibres, it should be hardened by maceration in alcohol, or by boiling. Its external and internal membranes may be then cautiously raised, and the different layers of muscular fibres examined, commencing with those most internal, and following carefully the course of the fibres.

1st. *In each of the ventricles* we find a proper set of fibres arranged so as to form a small conical sac, open at both extremities, the inferior opening being much the smaller: these may be termed *ventricular sacs*. In addition to the proper fibres, the ventricles have also a common set, which cover and unite the proper ones, and inferiorly at the apex of the heart become inflected and penetrate the small apertures above mentioned, in the ventricular sacs, on the internal surface of which they are expanded.

Now all these fibres arise from the tendinous zones, and terminate in them. They have been represented as forming six sets of layers in the left ventricle, and three in the right; but the fibres do not confine themselves to particular planes, but the planes mutually penetrate each other, and are moreover united by fibres reciprocally detached from one to the other. The superficial fibres proceed spirally from the base to the apex; those on the anterior surface incline from right to left, and those on the posterior surface from left to right. Having arrived at the apex of the heart, they are inflected, as already observed, towards its interior, and therefore present in this situation, when the pericardium has been carefully dissected off, the appearance of a star, the rays of which are not straight, but

curved. The inflected superficial fibres penetrate the openings in the ventricular sacs, and therefore both ventricles may be penetrated at the apex of the heart, without dividing the fibres. In the interior of the ventricles, some of the inflected fibres ascend on the interior of the same wall they descended on; others ascend on the opposite wall; and a third set terminate in the carneæ columnæ.

2dly. *In each of the aurieles* the proper fibres arise from the tendinous zones. — *On the left side,* some of them assume a circular arrangement in the vicinity of the auriculo-ventricular openings, and numerous oblique bands proceed from the same origin in various directions: one passes between the appendix and left pulmonary veins; another fills the interval between the pulmonary veins of the right and left sides, and others between the pulmonary veins of the same side, forming a border for their orifices — independent of which the orifices seem specially provided with proper sphincters. *On the right side,* the part of the auricle corresponding to the junction of the superior and inferior cavæ, has no muscular fibres except a small band on the right side of the orifice of the superior cava. In the rest of the auricle we distinguish two principal muscular bands, one embracing, in a circular manner, the right auriculo-ventricular opening, and the other descending from the interval between the right auricular appendix and superior cava, to terminate on the right side of the inferior cava. Between these two bands the muscular fibres are arranged in a fasciculated manner, constituting the musculi pectinati.

The superficial fibres of the auricles constitute a thin layer, passing transversely from one auricle to another, and arising and terminating in the tendinous zones.

From the above account, it follows that the right and left sides of the heart may be separated from each other by division of the common fibres, leaving the proper fibres uninjured. For this purpose an incision should be made with caution through the anterior fibres of the ventricles, parallel to the anterior fissure of the heart, and then the right and left sacs, above described, constituted by the proper fibres, may be separated with the finger. In order to separate the auricles, the incision should be made parallel to their posterior median fissure, and still greater caution is necessary here than in the separation of the ventricles. I have hitherto spoken of the ventricular sacs, for simplicity sake, as having a conical form. This is strictly true of the left side, all parts of the exterior of the left sac being convex; but on the right side, the part of the sac which is applied to the left ventricle is concave. Now the reverse occurs in the auricles, the right one presenting a convexity received into the concavity of the left one.

### *The Endocardium*

Is a pale transparent membrane, much more attenuated than the serous membranes, which, however, it strongly resembles. Its free surface is highly polished and glistening: its deep surface is united to the subjacent tendinous and fibrous structures, by very fine cellular tissue, which is often found thickened and altered by

disease. The endocardium is thicker in the left cavities of the heart than in the right, and thickest opposite the auriculo-ventricular and arterial orifices, in which situations it is often found morbidly thick and rough in consequence of chronic inflammation.

### *The Arteries of the Heart.*

*The* arteries of the heart are two in number, viz. the posterior and anterior.

The *Posterior or Right Coronary Artery* arises from the aorta, above the margin of one of the semilunar valves; and after communicating with the left coronary, behind the pulmonary artery, proceeds outwards in the groove between the right auricle and right ventricle. Having reached the inferior surface of the heart, it divides into two branches; *one* of which continues in the same groove, and winding round the base of the heart, anastomoses with the left coronary artery; it supplies the right auricle and ventricle. *The Second Branch,* from its size, appears the continued trunk. It descends on the inferior surface of the heart, along the septum ventriculorum, supplies both ventricles, and near the apex of the heart anastomoses with the left coronary. The branches of the right coronary, before its division, are the following: first, auricular branches, five or six in number, that supply the right auricle, — the septum auriculorum, and the parietes of the venæ cavæ; secondly, ventricular branches, much larger, to the right auricle; some of these descend on the superior

surface of the heart, others on the inferior, and one along its right or thin margin.

*The Anterior or Left Coronary Artery*, smaller than the right, arises from the aorta, above the margin of one of the semilunar valves; it then proceeds to the left, till it escapes from beneath the pulmonary artery and divides into a superior and inferior branch. The superior winds round the base of the heart in the groove between the left auricle and left ventricle, concealed by the coronary vein, and anastomoses with the right coronary artery. In this course its branches are distributed principally to the left ventricle; others go to the left auricle and the pulmonary veins. *The Inferior Branch* is the larger; it descends on the superior surface of the heart, in the groove between the two ventricles. Its first branches are to the commencement of the aorta and pulmonary artery; the rest are distributed to the ventricles, principally to the left.

### *The Veins of the Heart.*

The veins of the heart are the greater and lesser coronary.

The *Great Coronary Vein* commences at the apex of the heart, and ascends through the anterior fissure, gradually increasing in size. Having arrived at the base of the ventricles, it quits the coronary artery, and turns off at a right angle to the left side. In this manner it gets into the groove which separates the left auricle from the left ventricle, and having thus arrived at the inferior surface of the heart, it opens

into the posterior inferior part of the right auricle, as already described (p. lxx.). Immediately before its termination, this vein presents a remarkable ampulla or dilatation. In the ascending part of its course it receives branches from the septum ventriculorum and from the right and left ventricles; and during its transverse direction it receives descending branches from the auricle, and ascending and larger branches from the ventricle, — one of which follows the left margin of the heart. In its ampulla usually terminates a branch that ascends through the inferior interventricular fissure, and another that crossed from right to left between the right auricle and right ventricle. This vein has no valves, except the lesser Eustachian valve, already described.

The lesser coronary veins open separately into the inferior part of the right auricle. Among them we need only notice a small one that descends from the infundibulum of the right auricle, and another (*the Vena Galeni*), which ascends along the anterior margin of the heart.

*Varieties.*—The coronary vein has been seen to enter into the left auricle (*Jeffray, on the Fœtal Heart*); and Lecat relates a case in which it opened into the left subclavian vein (*Mém. de l'Acad. des Sciences*, 1738).

### *The Nerves of the Heart*

Are few in number; and even these Behrends erroneously supposed to be exclusively destined for its vessels, and not for its muscular fibres. They are

principally derived from the cervical ganglion of the sympathetic nerve, but a few of them are derived from the pneumogastric nerves. They are distributed in greater number on the right side than on the left.

### *The Lymphatics of the Heart*

Consist of a superficial and deep set. The superficial set form a net-work under the serous layer of the pericardium, and the deep set ramify between the endocardium and muscular fibres; and both of them follow the coronary vessels. Some of them unite with the lymphatics of the lung, and others terminate in the ganglions in front of the arch of the aorta and pulmonary vein.

THE

# SURGICAL ANATOMY

OF

# THE ARTERIES.

1.

THE

# PULMONARY ARTERY.*

☞ It is intended that those passages printed in small type should be omitted in the dissecting-room.

THIS vessel may be easily injected from the superior or inferior cava. It arises from the funnel-shaped pro-

* By passing needles through the chest at different parts, Dr. Hope ascertained the following points.—The centre of the trunk of the pulmonary artery is opposite to the interval between the second and third ribs of the left side, and is close to the sternum. A line crossing the sternum, and uniting the third rib of one side to that of the opposite side, would cross in front of the sigmoid valves of the pulmonary artery, which are a little on the left side of the mesial line. The aortic valves are *almost* directly behind them. [Dr. Hope's expression, "almost," which I have printed in Italics, implies that they are not exactly so, as I have shown (see p. lxvi.)] A vertical line descending along the left margin of the sternum leaves one-third of the heart to its right side, and two thirds to its left side; this one third is formed by the upper part of the right ventricle. The apex of the heart pulsates between the fifth and sixth

longation of the right ventricle, which we have already described as existing at the anterior and left part of its base. Its direction is upwards, backwards, and to the left side. After a course of about an inch and a quarter, it terminates by dividing into a right and left branch. In the angle between these branches (but more connected with the left than with the right

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ribs. The lungs descend along the margins of the sternum, being about two inches apart; and they overlap the base of the heart slightly on the right side, and more extensively on the left; then, receding from each other, they leave a considerable portion of the right ventricle, and a less extent of the lower part of the left, in immediate contact with the sternum. The right auricle is in front of the heart: at its right side, and upper part, a portion of it is overlapped by the right lung; and another (principally the appendix) is in contact with the sternum. The left auricle is situated deep behind, and to the left of the heart; at its upper part, opposite the interval between the cartilages of the third and fourth ribs. The extremity of the appendix is visible in front; but when the volume of the heart is natural, it is not in contact with the sternum, being considerably overlapped by the left lung.

The pericardium extends as high up as the second rib, and when distended is pear-shaped.

When the heart is enlarged, its long axis becomes placed more transversely, and its lateral diameter is increased: hence the right ventricle projects more considerably to the right side — sometimes under the whole breadth of the sternum; and the left extends far beyond the usual limits to the left — sometimes elevating that portion of the lung which overlaps it, so as to bring its whole surface and the tip of the auricular appendix in contact with the sternum. In addition to being broader, and placed more transversely, it also descends lower than natural; its apex beating sometimes between the sixth and seventh ribs, and its pulsations extending to the epigastrium.

branch) arises the ductus arteriosus, which in the fœtus equals in size, and seems like a continuation of, the pulmonary artery; it terminates in the concave side of the arch of the aorta, a little beyond the origin of the left subclavian artery. The pulmonary artery, in the course above described, forms a curvature, the convexity of which looks forwards and to the left side, and is covered by the serous layer of the pericardium, with the interposition of some adipose tissue. Its concavity looks backwards and to the right side, and corresponds to the commencement of the aorta. On either side it is related to the appendix of the corresponding auricle. We have already mentioned that this vessel, and the commencement of the aorta, have a common sheath formed by the reflexion of the serous layer of the pericardium; and that within the sheath, and between the vessels, descend filaments of the sympathetic nerve, to form the coronary plexus. If we now cut into the artery, and examine its interior, we observe that there are three sigmoid valves at its orifice, and that an incision through its anterior part will divide one of them; whereas an incision into the front of the aorta would nearly separate two of them, viz. the right from the left.

The middle coat of the pulmonary artery will be found to terminate towards the heart in a festooned edge, presenting three convexities, separated by three notches. Opposite each of these convexities the lining membrane of the vessel is doubled into a crescentic or *semilunar valve*, the free margin of

which looks upwards, and is interrupted by a little thickening, termed the Corpus sesamoideum, or Corpus Aurantii. Between the festooned edge of the middle coat and the heart is a fibrous ring or zone, which by its inferior margin is connected with the muscular fibres of the right ventricle; and from its superior margin sends up three thin triangular prolongations, which are received into the notches in the festooned edge of the middle coat.

*The Right Pulmonary Artery* crosses transversely behind the aorta and superior cava, to which consequently its anterior surface corresponds with the interposition of the serous sheath of the aorta. Posteriorly and superiorly it corresponds to the right bronchus, and inferiorly to the right auricle.

*The Left Pulmonary Artery*, shorter than the right, and less horizontal, ascends in front of the left bronchus, being covered anteriorly by the serous layer of the pericardium, except in the immediate vicinity of the lung, where it is covered by its corresponding veins. Above and behind it is the arch of the aorta, and beneath it the left auricle.

*Varieties.* — The pulmonary artery may arise from the aorta, or in common with it; or, secondly, the two ventricles may communicate at their bases, and the septum between the aorta and pulmonary artery be deficient. The pulmonary artery has been known to arise from the left ventricle, and the aorta from the right*: in such cases we either find the ductus arteriosus open, or the foramen ovale, or both. The pulmonary artery may arise from the left ventricle, the right being almost obliterated, and

* Langstaff, 4th vol. of *Lond. Med. Review*; and Baillie's *Morbid Anatomy*.

communicating with the left (p. xli.). The pulmonary artery may give off the subclavian artery (see page 72.). In a case related by Dr. Farre, it had two origins, — one from the right, and the other from the left ventricle; it then gave off the descending aorta, while an ascending aorta arose directly from the heart, and supplied the head and upper extremities. Lastly, in cyanosis, the pulmonary artery is frequently found contracted or obliterated at its origin. In this case, the blood reaches the lungs in passing through the aorta, ductus arteriosus, and right and left pulmonary arteries.

# II.

# THE AORTA.

☞ It is intended that those passages printed in small type should be omitted in the dissecting-room.

THE AORTA or great systemic artery consists of an arch, and descending portion.

The arch of the aorta may be exposed in the following manner:—The second, third, fourth, and fifth ribs should be sawed through anterior to their centres, and the cartilages of the first ribs divided. By raising the sternum and anterior fragments of the divided ribs, we can detach the soft parts from their posterior surfaces, taking care not to injure the mammary arteries that descend behind the cartilages of the ribs. The sternum may now be transversely divided at its inferior part, and forcibly thrown back on the front of the neck; lastly, the pericardium is to be divided longitudinally, and the soft parts covering the arch dissected.

The aorta, or great arterial trunk, commences in the form of an arch, which extends from the base of the left ventricle to the left side of the third dorsal vertebra. In this course its convexity is turned upwards, and its summit is on a level with the body of the second dorsal vertebra; its posterior extremity touches the spine, and in the adult subject its most prominent part in front is not more than three-fourths of an inch distant from the sternum. It is usually divided into three stages or portions, viz., an anterior, middle, and posterior.

*The anterior or ascending portion* arises from the base of the left ventricle, opposite the left side of the body of the fourth dorsal vertebra, and anterior and a little to the right side of the left auriculo-ventricular opening. From this origin it proceeds upwards, forwards, and to the right side, till it reaches the level of the cartilage of the second rib. In this course its *anterior surface* is related to the pericardium, the origins of the coronary arteries, the pulmonary artery; and the tip of the right auricular appendix. The *posterior surface* corresponds to a little of the left auricle and to the right pulmonary artery. The *left surface* is related to the pulmonary artery immediately before it divides; and the *right surface* first rests on the base of the right ventricle between its arterial and auricular openings, and corresponds in the rest of its course to the superior cava. The greatest part of this ascending portion is within the pericardium, the serous layer of which forms a sheath common to the aorta and pulmonary artery. This sheath also con-

tains the right inferior cardiac nerve which lies between the vessels as it proceeds to the coronary plexus of the heart. We may observe, also, that the serous sheath extends higher up on the aorta than on the pulmonary artery, and higher up on its right side than on its left. The fibrous layer of the pericardium is lost a little higher up on the external coat of the artery.

If we look at the origin of the aorta through the left ventricle, it appears a triangular opening, and more contracted than any other part of the arch is naturally found; immediately above this it enlarges and assumes a form nearly cylindrical, but not exactly so on account of certain deviations to be noticed hereafter. In order to examine its connexion with the heart, we may slit up the front of it longitudinally from the left ventricle. We then find that the aorta is united to the heart, internally by the continuity of their lining membrane, and externally by the serous layer of the pericardium passing up on the vessels as already described. Between these two layers we find at the very orifice of the aorta a *tendinous zone*, ring or hoop, connecting the middle coat of the artery to the muscular tissue of the heart. The inferior margin of this hoop is imbedded in the muscular fibres of the ventricle, which are inserted for a small extent on both its surfaces. The superior margin presents three semicircular notches, separated by angular projections; these notches correspond to three convex flaps, in which the middle coat of the artery terminates in the form of a festooned edge. The margins of these convex flaps are strengthened by an edging, or tendinous

cord, which connects them to the superior indented margin of the ring or hoop, above described. I cannot agree in opinion with Mr. Harrison, that between each two of these convex flaps, which he terms "roots of the middle coat," "the wall of the artery is formed only by the lining membrane of the heart, and the serous layer of the pericardium, which are here in apposition."—Vol. I. p. 5. I have frequently demonstrated the angular processes from the tendinous ring, which fill up the intervals between the flaps or roots; they are by no means as strong as the rest of the ring, but though very delicate, have considerable resistance, and are separated from the serous layer of the pericardium by cellular membrane, continuous with the external tunic of the artery.

On the inside of the Aortic opening we find three folds of the lining membrane forming *three semilunar valves*, the inferior convex margins of which are attached opposite the convex margins of these semicircular flaps; their free margins look upwards, and each of them is interrupted in its centre by a little thickening termed the *corpus Aurantii*, or *corpus sesamoideum*. When the aorta contracts, these valves are thrown back towards the centre of the aortic opening, and prevent the return of blood into the ventricle, which object is more completely effected by the corpora Aurantii, which close up the space which would otherwise exist at the common junction of the three valves. Immediately behind these valves the aorta presents three pouches or dilatations termed *the lesser sinuses of the aorta*. These exist at birth, but are better marked

in the adult than in the young subject, on account of the constant pressure of the blood during the contraction of the vessel. By *the great sinus of the aorta* is meant an enlargement of the tube at the upper part of its first stage, where the vessel begins to change its direction. It does not engage the whole circumference of the tube, but is limited to its anterior and right side. It is obviously the effect of the impulse of the blood, and is therefore better marked in the old than in the young subject.

*The middle portion* of the arch proceeds obliquely upwards, backwards, and to the left side, so that the term transverse usually applied to it is not correct: it terminates on the left side of the second dorsal vertebra. *Posteriorly* it is related to the lower extremity of the trachea and to the cardiac plexus and recurrent nerve. *Anteriorly* to the thymus gland, the left pneumogastric nerve, and its recurrent branch. *Above it* are the left vena innominata (to which it is united by a dense aponeurosis,) and the branches given off in this stage. *Beneath it* are the left recurrent nerve, the root of the left lung, and the ductus arteriosus, which enters the concavity of the arch a little below the origin of the left subclavian artery.

*The posterior or descending portion* of the arch extends from the body of the second to that of the third dorsal vertebra. *Posteriorly* it rests on the spine and longus colli muscle. *Anteriorly* it is covered by the root of the left lung. On its *right side* are the œsophagus and thoracic duct, and on its *left side* the pleura.

In these different stages, besides the various relations already enumerated, the artery is surrounded by a number of dark coloured *bronchial glands*. When these become enlarged by disease, to which they are very prone, they occasionally produce most serious effects, by their pressure on the air tubes, the vena cava, and large arteries which they accompany into the neck.

As the arch of the aorta is immediately adjoining both the anterior and posterior wall of the thorax, and is also surrounded by numerous cavities and tubes, it is evident that an aneurismal tumor affecting this portion of the vessel may burst in a great variety of situations. We frequently find it absorbing the sternum and pointing, or even bursting, anteriorly.* It has been known to burst into the right auricle,† into the pericardium,‡ the pulmonary artery,§ the trachea, bronchial tubes, and air cells,‖ into

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* Guthrie on the Arteries, p. 59, &c.

† Med. Chirur. Journ. vol. ii. Bulletin de Societè de Medicine a Paris, 1810, No. iii. p. 38.

‡ Smith. Dub. Med. Journal, No. xxvii.

§ Wells in the Transactions of a Society for the Improvement of Med. and Chirurg. Knowledge, vol. iii. p. 85. Sue in the Journal de Medicine, continue. t. 24, p. 124. Payen and Zeink Bull. de la fac. de Med. No. iii. 1819. Nannoni Trattato di Chirurgia ii. Obs. 74.

‖ *Cases of communication with the trachea* are related by Heurnius (in Lieutaud Hist. Anat. Med. ii. Obs. 802), Corvisart, p. 256. Boyer, Richerand (Mem. de la Societè d'Emul. IV. Annè) Bouillaud, (traitè da Maladies de Cœur & 107), Lambert Journal des Progrès iii. 1830. American Journal of Med. Sc. vii. 229. Wright (American Journ. of Med. Sc. iv. 345. Regnier Revue Med. i. 315, 1834, Corbin Journal Hebd. iii.) Montault, (Lancette Francaise, No. ix. Sept. 1834) &c. see

the mediastinum, œsophagus,* right and left pleuræ, and into the spinal canal;†‖ also to press upon and obstruct the thoracic duct,‡ or obliterate the subclavian§ or common carotid artery.‖ In some cases the tumor ascends behind the clavicle and simulates subclavian aneurism,¶ in other cases its pressure anteriorly has been known to dislocate the clavicle,** and the occurrence of dyspnea, aphonia,†† and dysphagia during its progress can be accounted for by pressure on the air passages, recurrent nerve, and œsophagus.

Mr. Smith has described in the ninth volume of the Dublin Medical Journal, a very remarkable case of aneurism of the ascending portion of the aorta, the front of which was divided by the pulmonary artery into two portions, one of which projected into the right ventricle, and the other into the left. From each of these cavities the sac was only divided by a very delicate membrane, that must have been absorbed, had the patient lived a very little longer.

*Development.*—The aorta is formed after the portal system, with which it is connected by a dilatation which is the rudiment

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also American Cyclopædia, Art. Aorta. *For cases of communication with the lungs*, see Palletta Exerc. Path. ii. 215. Lancet i. 222. Laennec, p. 427. Bouillaud Dict. de Med. et de Chirurg. prat. ii. 405. Revue Med. iii. 58, 1833. In a singular case related in the American Cyclopædia, vol. i. p. 174, the right lung was absorbed and represented by a membranous sac, formed principally by a large aneurismal tumor.

* As this accident is not peculiar to the arch of the aorta, I shall defer the numerous references till the thoracic aorta has been described.

† Laennec—also Guthrie op. cit. p. 95, and Saloman Petersb. Abhandl 1825, p. 164.

‡ Laennec. § Hodgson.

‖ Sir A. Cooper Med. Chir. Trans. i.

¶ Burns on the Head and Neck. ** Corvisart.

†† Huguier and Cruveilhier.

of the future heart.* In the young child it lies nearer the spine than in the adult, on account of the larger size of the thymus gland which lies in front of it, but as the right bronchus becomes developed, and the thymus gland absorbed, it advances nearer the sternum. We also find that in the young subject it is situated higher up than in the adult. This is owing to the thorax of the child having less proportional height, and for the same reason the arch is higher in the adult female than in the male. In some cases we find it unnaturally high, independently of the age or sex of the individual: a remarkable case of this kind will be noticed a little farther on. In the old subject the swell of the arch is considerably increased by the development of the great sinus.

## *Anomalies.*

It has been frequently noticed by modern anatomists, that the varieties in the form, situation, and branches of the aorta which we term anomalies, constitute the regular and constant disposition of these vessels in other animals. This I shall have occasion to illustrate as we proceed. The anomalies of the commencement of the aorta may be classed into those relating to its form, to its course, or to the branches given off.

### *Anomalies as to form.*

The aorta has usually at its origin the form of an arch. In some cases, however, this vessel has been observed to have no arch, but to divide soon after its origin into two trunks, one of which gave branches to the head and upper extremities, while the other became the descending or posterior aorta. This is the natural arrangement in the horse, ass, sheep, goat, camel, and in many other mammalia, especially those having long necks.

In other cases the aorta bifurcates as above, but *each* division gives branches to the head, neck, and upper extremity of the

* Beclard. Aorta. Dict. de Medicine.

corresponding side, and after encircling the trachea, they unite to form the descending aorta. This is analogous to the natural structure in reptiles.

In a remarkable case of this kind described by Malacarne, the aorta was double *almost from its commencement*, and there were *five* valves, the breadth at the point of bifurcation being to the antero-posterior measurement as three to two. There are two specimens in the Museum of the Royal College of Surgeons in Ireland, of the aorta having *four* valves at its origin.

A very singular case is related by Gintrac, in which the ascending aorta which arose from the heart, gave branches to the head and upper extremities, while the descending aorta was a continuation of the pulmonary artery.

Lastly, the aorta has been known to arise by two roots, one from the left ventricle and the other from the right.

2. *Anomalies as to the course of the aorta.*

In some cases the aorta instead of crossing to the left side passes backwards towards the right side of the spine, and then either descends on this side, or crosses over to the left behind the trachea and œsophagus.* In other cases there is a complete transposition of the viscera, and the direction of the heart, and origin of its great vessels are reversed—See Phil. Trans. 1793, p. 90; also Houston's Catalogue, p. 61, from which the following account is abridged. An elderly woman died of fever in the Richmond Fever Hospital; she had been a mother, had a good constitution, and during her lifetime no remarkable circumstance ever attracted attention. On dissection the systemic cavities of the heart were found on the right side, and the pulmonic cavities on the left, the aorta made it arch to the right side, and descended along the right side of the spine even to its termination in the iliacs. The vena cava descended on the left side of the spine. The left carotid and left subclavian arose from an arteria innominata, on the right side of which arose separately the right carotid and right subclavian.

* Meckel. Anat. t. ii. p. 312.

### 3. *Anomalies as to the Branches given off.*

1. *Varieties with two primary branches.*—There may be a common trunk on the right side, giving off the right subclavian, and both carotids. This is the natural disposition in the simiæ, and has been also observed in the dog, fox, wolf, lion, hyena, bear, and many other mammalia.

There may be a common trunk on the left side, giving off the left subclavian and both carotids.* This is a much rarer variety than the preceding.

There may be two arteriæ innominatæ, one giving off the right carotid and subclavian, and the other giving off the left carotid and subclavian.† This is the natural arrangement in the cheiroptera, and according to Cuvier, occurs in the delphinus phocanea.

There may be a left arteria innominata giving off the left carotid and subclavian, while the right carotid comes directly from the arch, and the right subclavian comes from the thoracic aorta.‡

Lastly, there may be two arteriæ innominatæ, one giving off the two carotids, and the other the two subclavians.§

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* Zagorsky. Mem. de Acad. de Science de Petersburg, 1809. t. i. p. 384.

† Malacarne Obser. in Chirurg. t. ii. p. 119.

‡ Green—"This tendency of the vessels towards the left side leads to an anomaly extremely rare, an example of which I have before me; in this variety, all the vessels arise from the left side of the arch. First the right carotid, which crosses the lower part of the trachea, giving off the right vertebral: next this arose the left carotid and the subclavian, nearly from the same point; the right subclavian is detached from the back part of the arch, a little below the left subclavian. It passed to the right side, behind the œsophagus and trachea."—Varieties of the Arteries, p. 7.

§ Meckel. Anat. vol. ii. p. 322. Haller de Cor. Hum. Fab. t. 4, p. 8.

*Varieties with three primary branches.* — This may consist in mere transposition of the vessels, as when we find an arteria innominata on the left side, and the right carotid and subclavian arising separately from the arch without any other transposition.* This is very rare.

The two carotids may arise between the subclavians by a common trunk.† This is the regular disposition in the elephant.

There may be a common trunk for the two carotids; on the left side of this the origin of the left subclavian, and at the extremity of the arch the origin of the right subclavian. ‡

Lastly, there may be an arteria innominata on the right side for the right subclavian, and two carotids; on the left side of this, the origin of the left vertebral, and still more to the left side the origin of the left subclavian. §

*Varieties with four primary trunks.* — In addition to the usual branches there may be a left vertebral arising between the left carotid and left subclavian ‖, as in the phoca vitulina; or a left vertebral arising beyond the left subclavian ¶; or an inferior thyroid artery, usually the right one, arising between the innominata and left carotid **; or a middle thyroid artery, arising in the same situation; or an internal mammary, or thymic branch, arising from the arch. ††

The right subclavian and carotid arteries may arise, not in common, but separately from the arch, in which case the right subclavian may be the first branch of the arch ‡‡; or may arise between the right and left carotids §§; or may arise between the left carotid and left subclavian ‖‖; or may arise beyond the left

* Meckel, vol. ii. p. 322.

† Tiedeman, plate iii. fig. 11.

‡ Walter, Mém. de l'Académie de Berlin, 1785.

§ Meckel, loco cit.

‖ Morgagni, De Causis, &c. Ep. iii. Art. 20. Sandifort, Obs. Anat. l. iv. p. 92.

¶ Meckel, Handbuch der Path. Anat. B. ii. Ab. 1. sec. 109.

** Walter, Mém. Acad. Berlin, 1785, table iii. fig. 2. Loder, nonnullis var. Art. p. 4.

†† Soemmering, Corp. Human. Fab. t. v. p. 121.

‡‡ Winslowe, p. 36.

§§ Huber, Acta Helvetica, t. viii. p. 75.

‖‖ Walter, l. c. p. 62. 1785. Harrison.

subclavian.* Or the reverse of this may occur, in which case the left subclavian is the first branch of the arch on the right side, and then follow right subclavian, right carotid, left carotid. † Or lastly, the vessels may arise from the arch in the following way: left carotid, right carotid, left subclavian, right subclavian. ‡

*Varieties with five primary branches.* — In addition to the three usual branches may arise the left vertebral, and the right internal

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* Of this variety there are many cases on record. Thus, Mr. Kirby presented to the College a preparation in which a piece of fish bone pierced the right subclavian artery as it passed behind the œsophagus. — (See Houston's Catalogue, p. 79.) It may, however, pass between the œsophagus and trachea, or even in front of this latter. In such cases the inferior laryngeal nerve does not curve under the artery, but arises from the pneumogastric in the middle of the neck, and passes directly inwards to the inferior part of the larynx. The first case in which this peculiar course of the right inferior laryngeal nerve was observed, will be found in the Edin. Med. and Surg. Jour. for 1823: it is related by Dr. Stedman. The next case is related in the same Journal (April, 1826), by Dr. Hart, who was moreover the first author that explained the reason of the deviation. He observes, that "in the earlier periods of the existence of the fœtus, the rudiment of the head appears as a small projection from the upper and anterior part of the trunk, the neck not being yet developed. The larynx at this time is placed *behind* the ascending portion of the arch of the aorta; while the brain, as it then exists, is situated so low as to rest on the thymus gland and *front* of that vessel. Hence it is that the inferior laryngeal nerves pass back to the larynx, separated by the ascending aorta — the left going through its arch, while the right goes below the arteria innominata." Now it can be readily understood how the ascent of the brain, as the neck becomes developed, brings higher up the origins of the recurrent nerves, and the ascent of the larynx on a deeper plane brings up their terminations, so that they are made to form loops — the right round the subclavian artery, and the left round the arch of the aorta. It is equally clear, that if the right subclavian arises in the manner above described, it will not have the effect of depressing the inferior laryngeal nerve into a loop.

† Meckel, Anat. l. ii. p. 321. ‡ Meckel, *ut suprà*, p. 320.

mammary—or left vertebral and right inferior thyroid;* or there may be the three usual branches with two vertebrals, one on either side of the left carotid.†

The subclavians and carotids may arise separately from the arch, with a common trunk for the left vertebral and inferior thyroid;‡ or with a right inferior thyroid artery; or with a left vertebral, in which case the right subclavian may be either the first§ or last branch.‖

I shall have occasion, hereafter, to notice particularly a very remarkable case observed in the Richmond Hospital School, in which five branches arose from the arch, in consequence of the subclavian and external and internal carotids of the right side coming off separately from the aorta.

*Varieties with six primary branches.*—The subclavians, carotids, and vertebrals, have been observed to rise separately from the arch, each vertebral between the subclavian and carotid of its own side.¶

Hence it appears, that omitting the coronary arteries, two is the smallest number, and six the greatest number of primary branches arising from the arch: these extremes are much less common than the intermediate numbers.

From the arch of the aorta usually arise five branches, namely, the two coronary arteries, the arteria innominata, the left carotid, and the left subclavian. The description of the coronary arteries will be found comprised in the description of the heart. We may now proceed to examine the arteria innominata.

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* Bæhmer. Obs. Anat. rar. fas. i. p. 11.

† Fioratti. Act. della Acad. de Pad. t. iii. P. 1, p. 31.

‡ Meckel. ut supra, p. 321.

§ Loder de nonnul. Var. Art.

‖ Koberwein de Vas. Curs. Ab. p. 16.

¶ Tiedemann. Meckel. ut supra. p. 322.

## THE ARTERIA INNOMINATA.

The arteria innominata arises from the arch of the aorta on the front of the trachea, a little to the left side of the middle line, and on a level with the cartilage of the second rib. From its origin it proceeds upwards, backwards, and to the right side, to terminate behind the right sterno-clavicular articulation, by dividing into the right subclavian and right carotid. It varies in length from about an inch to an inch and a half. *In front* it is crossed *near its origin* by the left vena innominata, and higher up the thymus gland rests on it. *Posteriorly* it rests on the trachea. *On the left side* we find the middle thyroid veins, and occasionally a middle thyroid artery separating it from the left carotid. *On the right side*, the pneumogastric nerve is closely related to its bifurcation, and lower down it is accompanied by the two inferior cardiac nerves.

*Anomalies.*—I have already noticed some of these, when treating of the branches coming from the arch of the aorta, I shall only add here, that it may arise from the descending aorta.* In some cases its length is less, and in others greater than I have assigned to it. Mr. Guthrie speaks of it being two inches and a half long in ordinary cases. Mr. Harrison has known it to ascend unusually high before it divided, and in one case he saw it distinctly pulsating on the trachea above the sternum. *Relations.*—According to Velpeau, the left vena innominata crosses it high up near its termination, and not at its origin. In this case the

* Green, loc. cit. p. 3.

superior cava was, of course, related to its right side. Velpeau seems to consider this as the normal arrangement, which is certainly not the case. *Branches given off.* — The middle thyroid artery of Neubauer when present, usually arises from this vessel —the inferior thyroid also may arise from it. — (Houston's Catalogue, p. 80.) Lastly, Meckel remarks, that the internal mammary sometimes comes from the arteria innominata. *Course.* — When it does not arise from the arch at the usual place, it must necessarily vary in its course; but Velpeau mentions a curious irregularity in its route, independent of this cause. In the case alluded to, it crossed to the left side, in front of the trachea, and returned to the right side, in passing behind the œsophagus, towards the first rib, to be distributed in the usual way.

The operation of tying the arteria innominata, has been performed three times on the human subject; first in 1818, by *Dr. Mott* of New York; afterwards in 1822, by *M. Graefe* of Berlin; and in this country by *Professor Lizars*, in 1837.* In none of these cases did the sudden abstraction of blood from the head, neck, and right upper extremity, produce any serious consequence, or even inconveniency; though, as Dr. Mott observes, "to intercept suddenly one fourth quantity of blood so near the heart, without producing some unpleasant effect, no surgeon, *à priori*, would have believed possible." The profession were not, however, altogether unprepared for these important results. For cases were occasionally observed in which the obstruction of considerable trunks supplying the brain, did not appear to be followed by any alarming consequence. Thus Pelletan dissected a case in which the right subclavian, right carotid, and termination of the arteria innominata, had been completely impervious during life, without having produced any serious consequence, and Mr. W. Darrach, has related a similar case, except that the right subclavian was in this instance pervious.

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* In Dr. Mott's case, the ligature came away on the fourteenth day, and the patient lived till the twenty-sixth. His death arose from hæmorrhage. M. Graefe's patient survived the operation sixty-seven days. Mr. Lizars' patient died of hæmorrhage on the twenty-first day.—(See *Lancet*, July 15. 1837.)

*Operation of tying the arteria innominata.**—The patient should lie on his back on a table, with the shoulders raised, and the head leaning backwards, and to the left side. An incision should then be made transversely from the external margin of the sterno-cleido-mastoid muscle parallel to and above the clavicle, till it terminates opposite the trachea: a second incision is then to be made along the anterior margin of the sterno-mastoid muscle, about three inches in length, and terminating inferiorly at the internal extremity of the preceding incision. On raising the flap, the sterno-mastoid muscle is brought into view. Under this a director should be conveyed from within outwards keeping it close to the muscular fibres, in order to exclude the small veins and nerves in this situation. On this we divide the sternal, and part (almost all according to Guthrie) of the clavicular origin of the muscle. We then by a similar proceeding divide successively the sterno-hyoid and sterno-thyroid muscles of the right side above the sternum. With the nail, or handle of the scalpel, we should now tear through the dense aponeurosis, covering the carotid artery, and in the same way dissect the small veins in this situation, not using the cutting edge of the knife as long as we can avoid it. When the carotid artery is exposed, it will serve (unless there be an irregularity) to conduct the finger to the arteria innominata, which, on account of the patient's position

* The operation here recommended is essentially the same as that adopted by Mott. Velpeau's operation described at page 18. is confessedly borrowed from one devised by Mr. O'Donnel of Liverpool, and published in a thesis by the late Mr. King.

will be drawn up from the thorax. The left vena innominata should now be depressed, and the aneurism needle* passed from without inwards and upwards, keeping it close to the vessel to avoid the pleura, and the pneumogastric and cardiac nerves, all of which are on its right side. By tying the artery near its termination, there is more room left for the formation of a coagulum.

Two other methods have been proposed to effect a ligature of the arteria innominata. The first is to trepan the upper piece

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* After the needle is passed round the vessel considerable difficulty is often experienced in depressing its handle, so as to raise its point sufficiently on the opposite side of the vessel. It became desirable accordingly, that some means should be contrived to obviate this difficulty, and facilitate the conveyance of the ligature in deep situations. For this purpose a very ingenious instrument was invented by Surgeon L'Estrange of Dublin, and advantageously used by Mr. Porter, in a case of subclavian aneurism, external to the scalenus muscle. Mr. Hargrave thus describes it in his Operative Surgery:—"It consists of a steel needle, less curved than ordinary, and possessed of two eyes, one anterior to the other; the curved portion of it is united to the remainder of the shaft, by means of a fine screw; the posterior eye being armed with the ligature, the needle is conveyed under the artery; as soon as it is perceived to have passed the vessel, in lieu of depressing the handle, which in some situations is nearly impracticable, a second instrument, that terminates in a small hook, is passed to the fundus of the wound, and on the opposite side of the artery, so as to hitch in the anterior eye, when the shaft of the needle is unscrewed from that part which holds the ligature, and allows it to be drawn from under the vessel, by the second instrument; the ligature will be then found to encircle the artery."

of the sternum, and tie this vessel below the left vena innominata, which is a very objectionable proceeding. The second has been proposed by Velpeau; the following is an abridged account of it: the operator stands at the *left* side of the patient's head: an incision is to be made through the skin, commencing at the internal margin of the *left* sterno-mastoid muscle, and carried downwards and towards the right side for the extent of about two inches. The next incisions should divide the two layers of fascia in this situation, so as to expose the trachea. The middle thyroid artery if present, and veins, are to be pushed aside, and if necessary, tied. The index finger is now made to glide between the right sterno-hyoid muscle and the trachea, in order to detect the arteria innominata. He then sinks with great caution and management from before backwards a curved staff, between the artery and vena cava superior. The posterior surface of the vessel is next to be denuded, and raised with the staff in the same cautious manner. Guided by this, the "stylet port fil," should be introduced from left to right, and from behind forwards. Velpeau says, that this operation is incontestibly more simple, more rational, and less dangerous than any other; and has, moreover, this advantage, that the same proceeding will serve marvellously, "servirait a merveille," for the ligature of either* of the subclavians in their first stage, or either of the carotids near their origin. On this operation I shall only make the following observations: 1st, that Velpeau assumes, what I do not think to be correct, that the left vena innominata usually crosses the *upper part* of the arteria innominata; 2dly, that great difficulty will be experienced in insulating the artery so low down, on account of the strong fascia that connects the left subclavian vein to the arch of the aorta; and lastly, if it were perfectly feasible, it would not be desirable to tie the artery so near its origin from the aorta.

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* I shall have occasion hereafter to notice Velpeau's opinion as to the facility and safety of putting a ligature on the left subclavian artery in its first stage.

## THE COMMON CAROTID ARTERIES.

On the right side the common carotid arises from the arteria innominata at the superior outlet of the thorax. On the left side it arises within the thorax, from the arch of the aorta. As they ascend in the neck they separate from each other, and terminate one on either side opposite the superior margin of the thyroid cartilage or os-hyoides. In this course they are separated inferiorly by the trachea and œsophagus, and superiorly by the larynx and pharynx. Each of them is crossed in front opposite the cricoid cartilage by the omo-hyoid muscle, which divides it into an inferior and superior stage.

*First or inferior stage of the Right common carotid.*

This vessel arises from the arteria innominata immediately behind the sterno-clavicular articulation, and inclines a little backwards as it ascends in the neck. In this stage it is covered *anteriorly* by the integuments, by the platysma myoides (except in the immediate neighbourhood of the sternum),—more deeply by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and still deeper by the descendens noni nerve and cervical fascia. *Internally* [illegible]

*First or inferior stage of the Left common carotid.*

This vessel arises from the arch of the aorta opposite the second dorsal vertebra. *Anteriorly* its origin is covered by the sternum, sterno-hyoid and sterno-thyroid muscles, and the commencement of the left vena innominata—higher up by the integuments, platysma myoides, fascia and descendens noni nerve. *Internally* it is related to the arteria innominata, trachea and thyroid gland, which usually overlaps it. *Externally* to the jugular vein and pneumogastric nerve (which

it is related to the trachea and thyroid gland, which often overlaps it. *Externally* it corresponds to the internal jugular vein and pneumogastric nerve, which latter lies deeply concealed between the artery and vein (the nerve, artery, and vein being contained in a common sheath). *Posteriorly*, it is crossed by the inferior thyroid artery, which separates it from the vertebral. The sympathetic nerve and its branches descending, and the recurrent nerve ascending, and some loose cellular tissue separate it from the spine and longus colli muscle. lies concealed deeply between the artery and vein). The thoracic duct, phrenic nerve, and left layer of the mediastinum are also related to its outer edge. *Posteriorly*, it rests on the trachea and œsophagus—then on the vertebral and inferior thyroid arteries and recurrent nerve. Higher up it is separated from the spine and longus colli muscle by the sympathetic nerve and its cardiac branches. These are the usual relations of the left carotid, but they may vary or their number be increased in consequence of irregularities.

Hence it appears, that the right and left common carotids differ in the following respects in their first stage:—The right comes from the arteria innominata, and the left from the arch of the aorta—consequently the left is longer than the right. The left lies on the front of the trachea and œsophagus, and is intimately connected with the thoracic duct—the right is not related in this way. On the left side the jugular vein overlaps the outer edge of the carotid artery inferiorly—on the right side it rather separates from the artery inferiorly.

*Second or superior stage of the common carotid artery.* In this stage it lies close to the spine; resting posteriorly on the longus colli muscle and sympathetic

nerve. Internally it is related to the larynx. Externally its relations are the same as in the inferior stage. In front it is covered by the integuments platysma myoides, and cervical fascia, and is moreover crossed by the sterno-mastoid branch of the superior thyroid artery, the trunk of which descends on a plane anterior and internal to it.

It would appear from the preceding account, that the trunk of the common carotid may be effectually compressed against the spinal column, so as to prevent hæmorrhage in case of a wound of the trunk or its branches.* Such pressure, however, could not in a great majority of cases be maintained sufficiently long in consequence of the great suffering produced by pressure on the adjacent nerves; still it is often of the greatest importance to know a means of arresting the the flow of blood, until a competent surgeon shall be in attendance to perform the operation.

The possibility of tying the carotid without impairing the functions of the brain, has been abundantly proved by dissection,† by experiments on brutes,‡ and ultimately by the success of the

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* *Acrel. Van Horne* in his annotations to the work of Botallus. *Larrey* Mem. de Chir. Mil. t. i. p. 309. Guthrie.

† In a man who died seven years after aneurism of the neck *Petit* found the common carotid obliterated. *Haller* has noticed a similar occurrence. *Baillie* found it obliterated on one side and contracted on the other, and Jadelot is said to have observed a case in which both common carotids were obliterated. In other parts of this book similar cases are recorded.—p. 15, &c.

‡ Such as Galen's and Vasalva's experiments on dogs.

operation on the human subject.* This will not appear surprising, if we recollect that the brain is supplied by four large arteries, viz.—the two carotids and the two vertebrals, and that these anastomose in the freest manner by large branches at the base of the brain, independently of their extensive communication by smaller branches. Mr. Hodgson is inclined to believe, that the brain in its natural state, receives a larger quantity of blood than is requisite for the due performance of its functions; having found that in a dog whose two carotids had been tied, the aggregate of the anastomosing tubes was not equal to the calibre of one carotid artery in its natural state. Hebenstreit relates the first case on record, in which it was tied in the human subject, in consequence of being divided during the removal of a schirrous tumor: the operation succeeded. In a second case Mr. Abernethy tied the common carotid for hæmorrhage from a lacerated wound; and though the patient did

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* There are now so many cases on record in which the carotid artery was successfully tied, that a sufficient number will be noticed incidentally as we proceed: I shall, therefore, only direct the student's attention to the remarkable case in which both common carotids were successfully tied by Dr. Mussey. Note p. 23.

It is by no means intended to convey that impairment of nervous power will never follow as a consequence of tying one or more of the principal trunks supplying the brain. On the contrary, in Sir A. Cooper's first case there was a paralysis of the leg and arm on the eighth day, which, however, disappeared on the twelfth. In Mr. Collier's case there was temporary numbness of the side of the face, without any disturbance of sensorial power; and in a remarkable case related by Magendie, there was injury of both the nervous and sensorial power. But as I shall give this subject a minute consideration in my book on the Nervous System, I shall at present only refer to the article carotid (in the *second* edition of the Dictionnaire de Médicine) and to Dr. Todd's Observations in the first volume, page 494, of his Cyclopædia of Anatomy.

not recover, yet his death was not occasioned by an insufficient quantity of blood being transmitted to the brain. Sir A. Cooper was the first that tied it for aneurism, and it has since been repeatedly tied, in consequence of wounds and ulcers extending to its branches,* and for aneurism by anastomosis of the orbit.† It has been observed, that when this vessel is the seat of aneurism, it usually occurs at its bifurcation, where there exists even in health an ampulla or slight dilatation.

*Irregularities affecting the ligature of the common carotid artery.*

A very remarkable case has been observed in a subject at the Richmond Hospital School, in which there was no common carotid on the right side—the external and internal carotid arising separately from the arch of the aorta. The order of the vessels were—right subclavian, right external carotid, right internal carotid, left common carotid, left subclavian. My colleague, Mr. Power, showed this preparation to the younger Tiedemann when he visited our School, and Tiedemann remarked, that no similar case had been observed or heard of by himself or his father. Mr. Harrison observes in a note in his book on the Arteries, vol. i. p. 29—"I have known two examples of the internal and external carotids arising on one side separately from the aorta;" but makes no other observation on the subject.

In some cases the common carotid is crossed in front by the inferior thyroid artery. In other cases the vertebral artery as-

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* Mayo. Luke. M'Dowell at the Richmond Hospital, &c.

† Travers, Dalrymple. It was also tied successfully by Professor Pattison, for a large aneurism by anastomosis of the cheek. *Med. and Phys. Jour.* vol. 48, and both common carotids were tied successively by Dr. Mussey of New Hampshire, in America, for aneurism by anastomosis on the crown of the head. (See the American Journal of the Medical Sciences for Feb. 1830.) Between the two operations there were only twelve days interval. The tumor was subsequently removed and the patient recovered.

cends behind it to pierce the third or second vertebra.* Cases are recorded, in which it ascended behind the angle of the lower jaw† before it bifurcated, and on the other hand, it may bifurcate as low as the inferior margin of the thyroid cartilage,‡ or at the sixth cervical vertebra§ : lastly, it sometimes happens, that there is no bifurcation, the common carotid and internal carotid forming a continuous trunk, which gives off the branches of the external carotid.

There are references in other parts of this work to instances in which the common carotid gave off the inferior thyroid, superior laryngeal, pharyngeal ascendens, superior thyroid and right vertebral.

### *The operation of tying the common Carotid Artery in its inferior stage.*

An incision is to be made through the integuments along the internal margin¶ of the sterno-mastoid muscle, for the extent of about three inches above the clavicle. In most cases a vein may be observed descending along the anterior margin of the sterno-muscle communicating with the facial above and thyroid plexus, or subclavian vein below; care must be taken not to injure this. A portion of the fascia is next to be raised in the forceps, and divided in a horizontal direction. Through this opening a director is to be in-

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* Burns p. 170. Hargrave, p. 69. Hird. L. Med. Gaz. Feb. 4, 1837.

† Green says, it may divide as high up as "the superior part of the styloid process," which must mean at the base of the skull, but he gives no explanation, instance, or authority.

‡ Hart. Todd's Cyclopædia Art. Carotid.

§ Burns on the Heart, p. 285. Morgagni Epist. 29, Art. 20.

¶ An incision between the two origins of the sterno-mastoid muscle as recommended by Sedillot, would rather lead to the vein than to the artery.

troduced, and the fascia slit up on it as far as necessary. The lips of the wound are now to be separated by retractors, the sterno-mastoid muscle being drawn outwards and the sterno-hyoid and sterno-thyroid inwards. On the front of the sheath thus exposed may be seen the descendens noni nerve, which is to be drawn inwards, and the sheath divided in the same cautious way as the fascia. A ligature is now to be passed round the artery, directing the needle from without inwards, in order to avoid the jugular vein, which sometimes* suddenly swells out during expiration, and then contracts during inspiration. Care is to be taken to avoid including the pneumogastric nerve which lies behind and between the vessels, and should be drawn outwards with the vein. The sympathetic and recurrent nerves are behind the sheath, and there is, comparatively, little danger of including them. In operating on the left side, the proximity of the thoracic duct is to be borne in mind.

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* As the vein fills at both its upper and lower extremity, an assistant should in such case compress it at both the upper and lower angle of the wound. In very many cases the vein so far from giving any trouble, is not even observed during the whole of the operation. In the case operated on by Dr. John Brown, "the internal jugular vein did not appear, nor was it a source of the slightest inconvenience during the operation." In a similar case related by Mr. Hodgson, "the jugular vein afforded no trouble in the operation: it was not even seen." (On the Arteries.) Lastly, Mr. Read of Dublin, whose experience is very considerable, is reported by Mr. Hargrave to have said that, "in all the operations he performed, or assisted in on this vessel, the vein was not found to interfere with the operation nor was it even seen."—Operative Surgery, page 68.

*Operation of tying the common carotid in its superior stage.*

In its superior stage it may be tied in the following, way:—The first incision is to commence a little beneath the angle of the lower jaw, and to terminate on the side of the cricoid cartilage. This incision will divide the skin, platysma myoides and cervical fascia and expose the sheath of the vessels with the descendens noni nerve lying on its front. The nerve is to be drawn outwards, and the sheath opened in the cautious manner already described. The artery being now exposed, the needle is to be carried around it from without inwards, taking care (as in the inferior operation) not to wound the jugular vein, nor include the pneumogastric nerve. It should also be remembered that the communicans noni (a branch of the cervical plexus) not infrequently descends in the sheath of the vessels between the carotid artery and jugular vein.

THE EXTERNAL CAROTID ARTERY.

The external carotid artery usually arises opposite the superior margin of the thyroid cartilage. It first ascends towards the submaxillary gland, but afterwards turning outwards, plunges into the parotid gland, through which it proceeds as far as the neck of the inferior maxillary bone, where it terminates by dividing into the temporal and internal maxillary arteries. In this course it describes a curvature, the convexity of which looks upwards, backwards and inwards towards the tonsil. Its *cutaneous surface* is covered by the platysma myoides and cervical fascia, by the posterior belly

of the digastric muscle, the stylo-hyoid muscle, the hypo-glossal nerve, and higher up by its corresponding vein, the facial nerve, and part of the parotid gland. Its *deep surface* is separated from the internal carotid by the stylo-glossus and stylo-pharyngeus muscles, the styloid process (or stylo-hyoid ligament), the glosso-pharyngeal nerve, and occasionally the pharyngeal branch of the pneumogastric nerve. At its commencement it lies on the superior laryngeal nerve.

I have already described the irregularities in the origin of this vessel; as we proceed I shall have occasion to notice several irregularities of its branches.

*Operation of tying the External Carotid.*

The external carotid may be tied either above or below the crossing of the posterior belly of the digastric muscle. For the latter* purpose an incision should be made through the integuments and platysma myoides, from beneath the angle of the jaw to the side of the thyroid cartilage. This incision will expose the digastric muscle, and by drawing it a little upwards the artery may be exposed and secured beneath the origin of its superior thyroid branch. Care should be taken not to include the superior laryngeal nerve which descends obliquely inwards behind the origin of the external carotid. In opening abscesses of the

* Mr. Guthrie is of opinion, that the ligature should be applied near its origin, that is, immediately below where the superior thyroid artery is given off.—*On the Arteries*, p. 391.

tonsil it should be borne in mind, that the convexity of the external carotid may be closely applied to the outside of the swollen gland.

The branches of the external carotid artery are nine in number, and may be included under the following heads:—the anterior, posterior, external, internal, and terminating.

The anterior branches are the superior thyroid, lingual and facial.

### *The Superior Thyroid Artery.*

The superior thyroid artery arises opposite the thyro-hyoid space. It first ascends towards the os-hyoides, and then descends on the side of the larynx (or a plane anterior and internal to the carotid) to terminate in the thyroid gland. In this course it describes a curvature, the convexity of which looks upwards, touches the os-hyoides, and corresponds to the concavity of a similar curvature in the lingual artery. *Posteriorly* it rests on some cellular tissue and the superior laryngeal nerve. *Anteriorly* it is covered by the integuments, platysma myoides, cervical fascia, and some small veins passing outwards from the larynx to the internal jugular vein—also by the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles, and an internal branch of the descendens noni nerve, which supplies the latter muscle. When it arrives near the thyroid gland, it divides into three terminating branches the internal, external, and posterior. *The internal terminating branch* descends along the internal margin of the corresponding

lobe, and unites (in forming an arch) with the corresponding branch of the opposite side. This branch usually gives off the inferior laryngeal which will be described lower down. *The external terminating branch* descends along the external margin of the corresponding lobe and anastomoses with the inferior thyroid. Lastly, *the posterior terminating branch* descends between the front of the trachea and thyroid gland, in the substance of which it is lost.

Before dividing into its terminating branches, the superior thyroid usually gives off the following branches:

1. *The hyoidean branch* which is small, passes inwards beneath the thyro-hyoid muscle, supplies the cellular substance in this situation and anastomoses, with that of the opposite side.

2. *The superior laryngeal branch* descends with the superior laryngeal nerve, passes beneath the thyro-hyoid muscle, and pierces the ligament of the same name. Here it divides into two branches, one of which ascends behind the os-hyoides to supply the anterior surface of the epiglottis and mucous membrane. The other descends on the inside of the ala of the thyroid cartilage, and terminates in the crico-arytenoidei and crico-thyroid muscles, and by a great number of small branches in the mucous membrane of the larynx.

3. *The sterno-mastoid branch* is constant, but variable in size. It crosses the sheath of the carotid artery to reach the deep surface of the sterno-mastoid muscle in which it is lost.

4. *The inferior laryngeal or crico-thyroid branch*

may come directly from the superior thyroid, but more usually arises from its internal terminating branch. It passes horizontally inwards in front of the crico-thyroid membrane, and along the inferior margin of the thyroid cartilage to anastomose with that of the opposite side, and supply the crico-thyroid membrane. This artery is pretty constant, though it varies as to size and origin. If it be absent, that of the opposite side will be found larger than usual. It is often a branch of the superior laryngeal.

*Anomalies.*—The superior thyroid artery sometimes arises by a trunk common to it and the lingual, or it may arise directly from the common carotid; in some cases the common carotid instead of bifurcating, divides into three branches the internal carotid, the external carotid, and the superior thyroid.

This artery lies on a plain anterior and internal to the common carotid, and therefore in attempts at suicide, is the vessel usually divided. In this case, we may either secure the bleeding vessel, or put a ligature on the external carotid beneath the origin of the former. This artery has been tied for the purpose of reducing the size of a bronchocele or preparatory to extirpating the thyroid gland, of which operation I shall have occasion to speak more particularly hereafter. The incision that exposes the external carotid will also expose its origin a little beyond which it may be tied. In a case related in Houston's Catalogue (p. 80) this vessel crossed the crico-thyroid membrane.

### *The Lingual Artery*

Is the next in order, but as the branches of the labial are more superficial, the student will find it expedient to dissect them first, and afterwards examine the course and branches of the lingual. This latter vessel arises a little above the superior thyroid, and nearly

opposite the os-hyoides. It may be divided into three stages: in the first, it extends from its origin to the outer edge of the hyo-glossus muscle; in the second, it passes behind (or more correctly speaking, deeper than) that muscle; in the third stage it gets the name of *the ranine artery*, and extends from the internal margin of the hyo-glossus muscle to its termination.

*In the first stage* it ascends a little, and then turns inwards, to get above the great cornu of the os-hyoides, making a curvature, the convexity of which looks upwards, while the concavity, looking downwards, corresponds to the convexity of the superior thyroid artery, from which it is separated by the extremity of the great cornu of the os-hyoides. In this stage it corresponds *posteriorly* to some loose cellular tissue, and to the superior laryngeal nerve, and *anteriorly* it is covered by the integuments, platysma myoides, cervical fascia, lymphatic glands, and some small veins. The lingual nerve lies superficial and superior to it.

*In the second stage* it passes upwards and inwards. The hyo-glossus muscle, which, in this situation, separates it from the hypo-glossal or ninth nerve covers its cutaneous surface, and a few other* fibres of the hyo-glossus muscle, and the origin of the middle constrictor of the pharynx, constitute its deep-seated relations.

* The lingual artery passes between the origin of the hyo-glossus muscle from the great cornu, and its origin from the body of the os-hyoides.

*In the third stage* it ascends a little to reach the base of the tongue, and then proceeds along the inferior surface of this organ between the genio-glossus and lingualis muscles; here it terminates in anastomosing with that of the opposite side. In this third stage it is accompanied by the ninth nerve, which at the anterior edge of the hyoglossus muscle turns under (that is superficial to) the artery, and then proceeds along its internal margin, towards the tip of the tongue.

The branches given off by the lingual are three in number. At the outer edge of the hyo-glossus muscle it gives off.

1. *The Hyoidean Branch* which supplies the epiglottodean gland and muscles attached to the os-hyoides: it anastamoses with that of the opposite side, and with the superior thyroid.

2. *The Dorsalis Linguæ.*—In many cases this is deficient or diminutive. When it exists it may be traced upwards and outwards towards the base of the tongue. Some of its branches are lost in the stylo-glossus muscle and base of the tongue, while others ascending supply the tonsil and velum palati. It lies immediately under the mucous membrane.

3. *The Sublingual Artery.*—This artery proceeds forwards and outwards to supply the gland of the same name. It also sends branches to the mucous membrane of the mouth, and often one that pierces the mylo-hyoid muscle to arrive at the anterior belly of the digastric. It anastomoses with that of the opposite side and with the submental. Sometimes the place of this artery is supplied by a large branch from

the submental, which pierces the mylo-hyoid muscle to arrive at the gland.

*Corresponding Veins.* The lingual artery is accompanied in its first and second stage by one or two *venæ comites*, that arise from a plexus at the base of the tongue, and terminate in the internal jugular vein. From the same plexus arises a *satelite vein of the lingual nerve*, which accompanies the hypo-glossal or lingual nerve, and opens into the facial or pharyngeal vein. Lastly, the *Ranine Vein* lies on the inferior surface of the tongue being superficial and external to the artery in its third stage, and then passes between the mylo-hyoid and hyo-glossus muscle to terminate in the facial vein.

The lingual artery may be exposed by an incision extending transversely from the os-hyoides to the margin of the sterno-mastoid muscle. The skin, platysma and facia being divided, the glistening tendon of the digastric muscle is brought into view. Beneath this, and lower down, is the hypo-glossal nerve, much duller in its appearance than the preceding; still lower and a little deeper the artery will be found.

Mr. Guthrie advises that the trunk of the external carotid should be tied whenever there is unmanageable hæmorrhage from its branches.

The ranine artery may be wounded in the operation of dividing the frenum linguæ. This will not occur if blunt pointed scissars be used, and their points directed *downwards* during the operation. In this case the hæmorhage is favoured by the vacuum produced in sucking, and by the heat and mobility of the parts. As the ranine arteries anastomose at their extremities

only, the right and left side of the tongue may be filled with different coloured injections. It has been proposed by Velpeau to puncture the ranine veins in cases of swelled tongue.

### *The Facial Artery.*

The *Facial Artery* (also called the labial or external maxillary) arises immediately above the preceding, and often by a common trunk with it. It ascends behind the digastric and stylo-hyoid muscles and hypo-glossal nerve, and penetrates the substance of the submaxillary gland. In this situation it lies behind the body of the inferior maxillary bone, and touches the internal pterygoid muscle; it then descends, winds round the base of this bone, and gets to its cutaneous surface where it may be found lying at the anterior edge of the masseter muscle: this may be termed its first stage. In the second stage it ascends tortuously along the side of the face, till it arrives at the internal angle of the eye, where it terminates in anastomosing with the nasal and frontal branches of the ophthalmic. In this latter part of its course it lies on the inferior maxillary bone, the buccinator muscle, the levator anguli oris, and the levator labii superioris alæque nasi; being covered by the platysma myoides, the origin of the triangular oris, the zygomatic muscles, and by a little of the margin of the orbicularis palpebrarum muscle.

*Its corresponding vein* is much less tortuous than the artery. Superiorly it communicates with the ophthalmic, and often with a large vein that descends on the middle line of the forehead; as it descends, it crosses

the cutaneous surface of the parotid duct, being external to the artery. On the body of the inferior maxillary bone, it lies close to the artery, touching its outer edge. It then descends superficial to the submaxillary gland, and either terminates in the external, internal, or anterior jugular vein.

Before arriving at the face the facial artery gives off several branches to the submaxillary gland, some of which extend to the tongue and mucous membrane of the mouth. It also gives off in this part of its course a branch to the internal pterygoid muscle, and an inferior palatine and inferior mental branch.

The *inferior palatine artery* is usually a small branch. It penetrates between the stylo-glossus and stylo-pharyngeus muscles, to arrive at the superior and lateral part of the pharynx, where it divides into two principal branches that are distributed to the pharynx tonsil and Eustachian tube. A tonsilitic branch sometimes comes off directly from the facial, and passes between the internal pterygoid and stylo-glossus muscles to its destination.

The *inferior mental* is a larger branch than the preceding; it runs along the base of the inferior maxillary bone towards the symphysis menti, being covered by the platysma myoides. Near the middle line it divides into two branches, one of which crosses in front of the anterior belly of the digastric muscle to anastomose with that of the opposite side, while the other ascends on the front of the chin to supply the integuments, and communicate with the inferior dental

branch of the internal maxillary artery. In some cases the inferior mental gives off the sublingual artery which more usually arises from the lingual.

The facial artery having arrived on the side of the face, gives off

First, external branches which supply the muscles, and integuments of the cheek and anastomose with the transversalis faciei artery: the most remarkable of these is the buccal artery.

The *buccal artery* runs backwards over the buccinator muscle, and then getting on the inside of the ramus of the lower jaw, terminates by anastomosing with the internal maxillary. Its branches are distributed to the buccinator and masseter muscles, to the fat of the cheek and the parotid gland and Steno's duct.

Secondly, internal branches which are the inferior labial, the coronaries, and the dorsalis nasi.

The *inferior labial* is distributed to the muscles and integuments of the lower lip and anastomoses with the submental and dental arteries.

The *inferior coronary** passes inwards in a very tortuous manner beneath the triangularis and quadratus oris, and proceeds along the margin of the

* Cruveilhier has seen this vessel run horizontally inwards along the *attached* margin of the lower lip, and then ascend vertically to the *free* margin where it divided into two equal branches, one passing to each angle of the mouth so as to constitute a second coronary vessel smaller than the first.

lower lip, close to its mucous membrane, where it anastomoses with that of the opposite side. In its course it supplies the above-mentioned muscles and anastomoses with the inferior labial, submental and dental arteries.

The *superior coronary artery* arises near the commissure of the lips, and runs tortuously inwards between the labial glands and mucous membrane of the upper lip. On the middle line it anastomoses with that of the opposite side, and sends upwards, towards the septum of the nose, a small branch termed *the artery of the filtrum.* Its branches are distributed to the muscles, integuments and mucous membrane of the upper lip,—also to the gums where they anastomose with branches of the inferior dental.

The *dorsalis nasi* ascends obliquely inwards, and distributes its branches to the muscles, cartilages, and integuments of the nose, after which it anastomoses with that of the opposite side. Some of its minute branches pierce the fibro-cartilages to reach the mucous membrane. We often find the place of this artery supplied by a number of small branches; or on the contrary, it may be a very considerable single branch, in which case the angular or terminating branch is particularly small.

Lastly, the *angular artery* is the terminating branch of the facial. It ascends between the origins of the levator labii superioris alæque nasi, and anastomoses with the nasal or terminating branch of the ophthalmic artery. Our incision into the lacrymal sac will be external to this vessel.

**The facial artery can be readily compressed or tied, as it is passing over the body of the inferior maxillary bone.**

At its origin this vessel is covered by a few lymphatic glands, some of which accompany it on the face. These may enlarge and displace the submaxillary gland, so as to occupy its natural position. A tumor of this kind may be removed without dividing the trunk of the facial; and such is probably the nature of many of those operations that have been termed extirpation of the submaxillary gland. Mr. Colles doubts the possibility of removing it, on account of its connexion with the facial artery and its dipping behind the mylo-hyoid muscle, (p. 137,) but a still greater difficulty arises from its vicinity to the lingual nerve, and its intimate connexion with the gustatory.

In some amputations of the side of the lower jaw its trunk is necessarily cut across, and care should be taken to divide it on the bone and not beneath it, lest it should retract too deeply to be reached. Its coronary branches are divided in the operation for hare lip; it is not necessary to tie them, but the suture needle must be passed sufficiently deep to close the posterior part of the wound, as otherwise there might be serious hæmorrhage into the mouth.

There is no artery presents greater varieties either as to origin, termination, or size; it sometimes arises in common with the lingual. In many cases it terminates by its coronary branches, and in others by the dorsalis nasi; in these cases the branches of the facial are replaced by those of the transversalis faciei: on the other hand, according to Sœmmering, it may extend to the forehead, giving off the palpebral and lacrymal arteries. On one side there may be a large facial artery, and a mere vestige on the other.

The facial artery communicates with the internal maxillary by the infra-orbital and inferior dental branches of the latter, and with the internal carotid by its inosculation with the nasal branch of the ophthalmic.

### *The Occipital Artery.*

The *Occipital Artery* arises from the posterior margin of the external carotid, nearly opposite the origin which the lingual artery has from its anterior margin. It may be divided into three stages.

*In its first stage* it runs upwards and backwards towards the digastric groove of the temporal bone, passing obliquely through the arch formed in the neck by the hypo-glossal nerve, which is, therefore, said to hook round it. In this course the occipital artery follows the inferior margin of the posterior belly of the digastric muscle, except superiorly where that muscle covers it, forming one of its *superficial relations;* the other superficial relations are the sterno-mastoid muscle and the skin and fascia of the neck. Its *deep seated relations* are the internal carotid artery, the pneumogastric nerve, and the internal jugular vein, from which last it is separated by the spinal accessary nerve.

*In its second stage* it grooves the temporal bone in passing from before backwards, between the mastoid process of the temporal bone and the external margin of the rectus capitis lateralis muscle, to arrive in the posterior region of the neck.

*In its third stage* it ascends obliquely inwards and ramifies on the occipital region of the head. In this stage it often passes superficial to the lesser complexus muscle, forming a kind of semicircle that embraces its lateral margins and posterior surface; in other cases it is covered by that muscle, and then ascends through

the fibres of the greater complexus muscle, and appears in the triangular space which the splenii capitis muscles form on the middle line in the superior part of the neck. In this space it is covered by the trapezius muscle, and then ascends on the back of the head, through the fibres of the occipital muscle, in company with the posterior branch of the second cervical nerve.

The first branches of the occipital artery are distributed to the posterior belly of the digastric muscle, and to the stylo-hyoid and sterno-mastoid muscles. It occasionally gives off *the stylo-mastoid artery*, which enters the stylo-mastoid foramen and anastomoses with a branch of the middle meningeal. As it lies on the side of the jugular vein, it sometimes gives off *a meningeal branch*, which enters the foramen lacerum posterius, and is distributed to the dura mater in the posterior and lateral region of the cranium. Farther on, it communicates with the vertebral artery, and sends one or more large tortuous branches downwards to the muscles on the back of the neck. These branches anastomose with the cervicalis superficialis and cervicalis profunda arteries. Lastly, it gives off *a mastoidean branch* which passes through the mastoid foramen, and is distributed to the dura mater of the occipital fossa. The terminating branches of the occipital artery ascend tortuously in the course of the lambdoidal suture to supply the occipito-frontalis muscle and integuments, and to anastomose with the temporal and posterior auris, and with the occipital of the opposite side. We sometimes find one of those small

branches pass through the parietal foramen to be lost in the dura mater.

It may be necessary to tie the occipital artery in case of profuse hæmorrhage from its branches. The incision already recommended for exposing the external carotid will also expose this vessel in the commencement of its first stage, or an incision may be made along the lower margin of the posterior belly of the digastric muscle, on raising which the artery is brought into view. Care should be taken not to injure or include the hypo-glossal nerve.

Mr. Harrison observes that in its third stage the occipital "artery can be exposed about an inch behind the mastoid process by dividing a portion of the trapezius and splenius capitis muscles." He admits, however, that "the peculiar density of the surrounding cellular tissue, and the great size of the veins render the dissection difficult." To this I may add that the depth of this artery behind the mastoid process is very variable, and unless there be a wound to guide to the vessel, it is not an operation that should be attempted.

*Anomalies.*—In some cases this artery arises from the internal carotid.* Dr. Green relates a case in which it rose from the vertebral†. Lastly, it may give off the pharyngea ascendens.‡

### *The posterior auris artery.*

The posterior auris is one of the smallest branches of the external carotid: it arises in the substance of the parotid gland, nearly opposite the apex of the

* Tiedeman. Exp. Tab. Art. p. 81.
† Green, p. 10.
‡ Op. Cit. p. 9.

styloid process, and ascends along the superior margin of the posterior belly of the digastric muscle, till it arrives at the interval between the external auditory canal and mastoid process. There it divides into two branches, an anterior and posterior. *The anterior branch* is distributed to the internal or deep surface of the pinna. *The posterior branch* ascends between the retrahens auris muscle and bone, and supplies the integuments covering the mastoid process, and the temporal and retrahens auris muscles.

Before its bifurcation the posterior auris sends branches to the parietes of the external auditory canal, to the parotid gland, and to the digastric and stylo-hyoid muscles. It also gives off *a stylo-mastoid branch*, which enters the stylo-mastoid foramen, and after supplying the lining membrane of the aqueduct of Fallopius and the tympanum and semicircular canals, terminates by anastomosing with a branch of the dura mater that enters by the Hiatus Fallopii.

In cutting down on the facial nerve to remove a portion of it after its exit from the stylo-mastoid foramen, the trunk of this artery is usually divided, and its stylo-mastoid branch is necessarily so.

Mr. Harrison relates a case in which it was tied in front of the mastoid process for aneurism by anastomosis on the external surface of the pinna—but without success.

*Anomalies.*—The posterior auris sometimes arises by a trunk common to it and the occipital and as we will find lower down. It has been known to give off the transversalis faciei.

The only internal branch of the external carotid is the pharyngea ascendens.

### *The Pharyngea Ascendens Artery.*

This vessel may be exposed by the same dissection recommended for exposing the internal carotid, and, therefore, the student would find it more expedient to defer its examination at present.

The pharyngea ascendens is the first and smallest branch of the external carotid. After its origin it ascends in the neck, being related—*posteriorly* to the spinal column, the rectus anticus muscle, and the superior laryngeal nerve—*anteriorly* to the stylo-pharyngeus muscle—*internally* to the pharynx, and *externally* to to the superior cervical ganglion. In this course it gives off a few irregular branches to the muscles of the pharynx, and terminates by dividing into the pharyngeal and meningeal branches.

The *pharyngeal branch* passes obliquely upwards and inwards, and sends off a number of twigs, some of which ascend through the superior constrictor of the pharynx, while others descend in the substance of the middle and inferior constrictors; they anastomose with branches of the superior thyroid and lingual. The *meningeal branch* ascends between the carotid artery and jugular vein, and supplies these vessels, the pneumogastric nerve, the Eustachian tube, the rectus capitis anticus and longus colli muscles. It then passes through the foramen lacerum posterius to ramify on the dura mater, having previously sent a small branch into the cranium through the car-

tilaginous substance that fills the foramen lacerum anterius.

This artery is not very liable to accident on account of its deep situation. Scarpa, however, relates a case in which it was ruptured.

*Anomalies.*—The pharyngea ascendens is sometimes a branch of the common carotid artery, and in still rarer cases it may arise from the internal carotid, in which case there is usually an accessary pharyngeal from the external carotid. It has also been observed to arise from the occipital,* or from the superior thyroid,† or facial.‡ Finally, there are sometimes two, and at other times three of them.§

The only external branch of the superficial carotid is the transversalis faciei.

### *The Transversalis Faciei Artery.*

This artery usually arises from the outer part of the external carotid a little before its termination. At its origin it is imbedded in the parotid gland, through which it proceeds outwards towards the integuments, then turns round the ramus of the lower jaw, and ascends slightly on the cutaneous surface of the masseter muscle. In this situation it lies above the duct of the parotid gland, concealed by the socia parotidis and surrounded by the filaments of the facial nerve. This

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* Cruveilhier Ang. p. 102.
† Meyer Lehre von der Blut, p. 49.
‡ Green, p. 9.
§ Sœmmering op. cit. p. 126.

artery sends a twig to the masseter muscle which anastomoses with a branch of the internal maxillary; farther on it sends several twigs to the parotid gland and its duct, and after supplying the zygomatic muscles, the orbicularis palpebrarum and the integuments, it terminates by anastomosing with the infra-orbital, buccal and facial arteries.

*Anomalies.*

In many cases this artery arises from the temporal. Dr. Hart has seen it arise from the external carotid, "opposite the angle of the jaw, beneath which it passed forwards and joined the labial at the anterior edge of the masseter muscle." He has also seen it arise from the posterior auris. When the facial artery is small this vessel is proportionally large, and gives off the dorsalis nasi,—or angularis,—or both.

The terminating branches of the external carotid are the temporal and internal maxillary.

### *The Temporal Artery.*

The temporal artery arises opposite the neck of the inferior maxillary bone, and ascends through the parotid gland in front of the external auditory canal. It next passes between the attrahens auris muscle and the longitudinal ramus of the zygoma, and ascends into the temporal region where it lies on the temporal fascia, covered by an aponeurosis which is of considerable strength in the vicinity of the zygoma but becomes gradually weaker as it is traced upwards. In the middle of the temporal region it terminates by dividing into two branches.

Previous to its subdivision it sends branches—forwards to the masseter muscle and temporo-maxillary articulation—backwards to the pavilion and auditory canal—and inwards a

*Middle deep temporal artery*, which arises immediately above the zygoma, pierces the temporal aponeurosis, and divides into several branches that ramify in the temporal muscle, and communicate with the other temporal arteries.

The terminating branches of the temporal artery are the anterior and posterior.

*The anterior* ascends tortuously towards the forehead; supplies the integuments, orbicularis palpebrarum and muscles of the forehead, and anastomoses with the corresponding artery of the opposite side, and with the frontal and supra-orbital arteries. This is the branch selected for arteriotomy.

*The posterior* terminating branch ramifies on the side of the head, and anastomoses with that of the opposite side, and with the occipital and posterior auris.

The temporal artery is not subject to much variety: it may, however arise nearer the angle of the inferior maxillary bone than I have above described, in which case it usually gives off the transversalis faciei. This vessel should never be opened near the zygoma as unmanageable hæmorrhage or inflammation and abscesses may be the consequence. Mr. Harrison mentions a case in which this practice was followed by a varicose aneurism. The anterior branch should be selected for arteriotomy, and should a small aneurism be the result, as occasionally happens, it may be cured by compression or by making an incision through the tumor and dressing it from the bottom. Mr. Liston advises to divide the artery at each side of the tumor and tie the bleeding extremities.

## *The Internal Maxillary Artery.*

The internal maxillary artery may be exposed in the manner described in the note.* It is larger than

* Having removed the brain and uncovered the masseter muscle, we may carry a very small and pointed saw upwards behind the posterior extremity of the zygoma, and divide it from within outwards as near its roots as possible. We next remove the roof and contents of the orbit in the usual manner, and sink the point of the saw into the anterior extremity of the spheno-maxillary fissure, and from this point make two incisions, one upwards and outwards — through the outer wall of the orbit to terminate at the external angular process of the frontal bone — the other downwards and inwards, through the floor of the orbit to terminate on the outside of supra-orbital foramen. These two incisions will include the greater part of the malar bone, and the zygoma will fall down, carrying with it the masseter muscle. Our next object is to detach the temporal muscle and vessels from the temporal fossa, and allow them to hang down from the coronoid process of the inferior maxillary bone. We then introduce a knife into the temporo-maxillary articulation *above* the fibro cartilage, and divide the portion of the capsular ligament that connects the latter to the circumference of the glenoid cavity. Lastly, we make two incisions, meeting internally at an angle, so as to include the greater part of the squamous plate of the temporal bone, and the great wing of the sphenoid bone; one of these incisions may commence immediately in front of the ear, and be continued vertically down through the side and base of the skull till it terminates immediately behind and external to the spinous process of the sphenoid bone; the second may be made with a small saw, and as the malar bone is already removed it may be readily made to connect the inferior angle of the sphenoidal fissure, with the internal extremity of the preceding incision. The foramen ovale and foramen rotundum should lie unopened on the inside of this last cut. A slight stroke of the hammer against the bone between these two incisions will detach it, and give a full view into the zygomatic fossa. Its branches may then be dissected. The vidian and posterior palatine canals.

the temporal; immediately after its origin, it runs horizontally forwards on the inside of the neck of the inferior maxillary bone, which it separates from the internal lateral ligament. We next find it passing forwards and inwards, forming a curvature the concavity of which looks upwards and embraces the external pterygoid muscle; in this part of its course it lies in a triangular space, bounded by the external pterygoid muscle above, the internal pterygoid beneath, and the ramus of the lower jaw externally. In the same triangular space we observe the gustatory and dental nerves and, usually, the buccal nerve descending. In the next part of its course, we find the internal maxillary artery running upwards and inwards towards the root of the pterygoid process, in passing between the outer surface of the external pterygoid muscle, and the fibres of the temporal muscle. Finally, it sinks between the two origins of the external pterygoid muscle into the pterygo-maxillary fossa where it terminates. In some (not very rare) cases the artery passes to its destination, not through the triangular space above described, but between the external pterygoid muscle and the base of the skull. Let us now examine its branches in the order in which they arise.

1. *The middle meningeal artery* is the largest branch of the internal maxillary. It arises on the inside of the neck of the lower jaw, and ascends obliquely inwards to the base of the skull, behind the external pterygoid muscle, which consequently separates it from the continued trunk of the internal maxillary artery. In this

can be readily broken into if a vertical section of the skull be previously made through the adjacent nostril.

course it is crossed by the aural nerve which it usually pierces. It then enters the spinous foramen in the base of the skull after passing between the origin of the circumflexus palati muscle in front and the internal lateral ligament of the lower jaw posteriorly. In this part of its course, it supplies the pterygoid muscles, the muscles of the pharynx, and the temporal and sphenoid bones.

Having penetrated the skull, the middle meningeal artery ascends beneath the dura mater into the middle fossa of the cranium, and terminates by dividing into an anterior and posterior branch.

Before its division it sends a branch through the spheno-frontal fissure to terminate in the lacrymal gland; another through the hiatus Fallopii, which supplies the facial nerve and anastomoses with the stylo-mastoid artery; and a third, through the canal for the internal muscle of the malleus, to be distributed on the lining membrane of the tympanum.

*The anterior terminating branch*, much larger than the posterior, ascends through a groove (which afterwards becomes a canal) in the great wing of the sphenoid bone and the anterior inferior angle of the parietal bone. In this course it passes about an inch behind the external angular process of the frontal bone, and divides into numerous branches that irradiate in all directions on the internal surface of the parietal and adjacent bones: these branches are principally lost on the dura mater, a few of them penetrate the sutures and supply the bones.

*The posterior terminating branch* curves backwards as it ascends on the internal surface of the squa-

mous plate of the temporal bone. Its branches communicate with each other, and terminate in the dura mater and bone.

2. *The inferior dental artery* arises from the inferior margin of the internal maxillary, nearly opposite the origin of the middle meningeal, and runs obliquely downwards and forwards, between the internal lateral ligament and ramus of the lower jaw. In this course it sends numerous branches to the pterygoid muscles, and to the gustatory and inferior maxillary nerves. Lower down it gives off a *mylo-hyoidean branch* which descends in the groove leading from the dental foramen, and supplies the mylo-hyoid muscle and mucous membrane of the mouth. Immediately after giving off this last branch, the inferior dental artery enters the dental foramen, in company with the dental nerve, which is situated in front of it. It descends beneath the alveoli, till it arrives at the first molar tooth where it divides into two branches—one of them is continued to the symphysis menti, supplying the alveoli of the canine and incisor teeth—the other escapes by the mental foramen to supply the integuments, and triangularis and depressor labii inferioris muscles; it anastomoses with the adjacent branches of the facial artery. In its course through the inferior maxillary bone it sends branches into the alveoli, each of which penetrates the bottom of the tooth to be distributed on the membrane lining its cavity.

3. *The posterior deep temporal artery* arises from the internal maxillary, while the latter is passing between the two pterygoid muscles; it next ascends between

the temporal and external pterygoid muscles, and then between the temporal muscle and side of the cranium, to all of which it sends numerous filaments that ultimately terminate in anastomosing with the superficial and other deep temporal branches.

4. *The masseteric artery* also arises in the triangular space between the two pterygoid muscles and ramus of the lower jaw. It passes outwards through the sigmoid notch that separates the coronoid process from the condyle, and then descends on the outer side of the ramus, supplies the masseter muscle and anastomoses with the transversalis faciei artery.

5. *The pterygoid branches* are numerous: some of them are distributed to the internal pterygoid muscle, and a still greater number to the external pterygoid.

6. *The buccal artery* runs tortuously, downwards forwards, and outwards, between the two pterygoid muscles, and in company with the buccal nerve. Having arrived at the anterior margin of the ramus of the inferior maxillary bone, it penetrates the cheek and divides into a number of branches which are distributed to the platysma myoides, buccinator and zygomatic muscles, and also to the integuments of the cheek, and to its mucous membrane and follicles. It anastomoses with the facial, infra-orbital and transversalis faciei arteries: in some cases it is deficient, and in others it arises from some other branch of the internal maxillary.

7. *The anterior deep temporal artery* ascends in the anterior part of the temporal fossa to supply the temporal muscle and anastomose with the other temporal

arteries. Some of its branches penetrate the malar bone to reach the lacrymal gland, and communicate with the lacrymal artery.

8. The *posterior superior dental artery* descends tortuously on the back of the antrum. Some of its branches pierce the superior maxillary bone, and supply the molar teeth and mucous membrane of the antrum, while others are distributed to the teeth, gums, and buccinator muscle: they anastomose with the labial, buccal and infra-orbital arteries.

9. The *infra-orbital artery* passes through a canal of the same name in the floor of the orbit, in company with the infra-orbital nerve beneath which it lies. In this course it sends some small branches to the inferior rectus and inferior oblique muscles of the eye. Having arrived at the anterior part of this canal, it gives off the *anterior superior dental branch*, which descends through the anterior wall of the antrum, to supply its mucous mem brane and the canine and incisor teeth. After giving off this branch, it leaves the infra orbitar canal, and is found on the face beneath the outer head the levator labii superioris alæque nasi, and lying on the levator anguli oris. In this situation it supplies the adjacent muscles, and anastomoses with the facial, dental, buccal and nasal arteries.

10. The *vidian artery*, extremely small, passes backwards through the root of the pterygoid process. It supplies the Eustachian tube and pharynx and anastomoses with the pharyngea ascendens.

11. The *superior palatine artery* descends obliquely forwards through the posterior palatine canal. In this

situation it sends two or three small branches through the accessory palatine canals to the velum palati. The continued trunk after leaving the posterior palatine canal advances on the roof of the mouth, and is distributed to its lining membrane, and to the gums and superior maxillary bone. Through the anterior palatine canal it communicates with the spheno-palatine artery.*.

10. The *spheno-palatine artery* may be considered as the terminating branch of the internal maxillary. It passes through the spheno-palatine foramen into the cavity of the nose, where it gives off a pterygo-palatine branch, and then divides into its terminating branches. The *pterygo-palatine branch* sometimes comes off directly from the internal maxillary; it passes backwards through the pterygo-palatine canal, and supplies the pharynx and Eustachian tube. The *terminating branches* of the spheno-palatine are two or more in number. One of them descends on the septum with the spheno-palatine nerve, and communicates with the superior palatine artery. The others are distributed in the superior and middle meatus, in the antrum and in the posterior ethmoidal cells. They communicate with the ethmoidal arteries, and form between the mucous membrane and periosteum, a vascular network, deeply tinging the former membrane.

* The branches of this vessel may be the seat of aneurism by anastomosis as in a case observed by Velpeau.

The following quotation relative to the internal maxillary artery is translated from a note in Marjolin's Anatomy:—"Buisson, one of the continuers of Bichat's Anatomy says, that beyond the condyle the internal maxillary artery forms a curvature, in order to pass directly inwards, and sink between the two pterygoid muscles. This disposition described by Buisson is seldom met, and should be considered as a variety. Haller, Sabatier, Boyer, Sœmmering and Portal, say that, that the internal maxillary artery is situated in front of the external pterygoid muscle, or what comes to the same, that it is placed between this muscle and the temporal."

If this criticism were just, every author who described this artery as passing between the pterygoids would be in error, and Cloquet, Harrison, and myself, would be involved in the censure. The fact is, that when this vessel has got on the inside of the neck of the lower jaw as Marjolin himself, and the writers he has quoted describe, it *then* passes between the pterygoid muscles, that is, between *their Insertions*, from which situation it subsequently ascends between the temporal and external pterygoid. Whereas, Marjolin overlooks this fact, and supposes the expression passing between the pterygoids to imply its passage between *their Origins*, which is unquestionably a variety, and not the general course of the vessel. I have often observed this variety: after ascending between the origins of the pterygoids it passes between the external pterygoid and base of the cranium. I have known it to take this direction on one side of the head, and the regular course on the opposite side in the same subject; and the same has been observed by Cruveilhier.

The middle meningeal branch of this vessel ascends through a canal in the cranium, about an inch behind the external angular process of the frontal bone, and may therefore be wounded in the operation of trephining. The hæmorrhage, however, may be readily controuled by a dossil of lint.

In the 8th volume of the Medico-Chirurgical Transactions, a case is related, in which Mr. Brodie tied the carotid artery in

consequence of hæmorrhage from the dental branch of the internal maxillary artery after extraction of a tooth; the hæmorrhage, however, proved fatal. In ordinary cases of this kind we may plug up the socket, or apply the actual cautery, or if practicable the tooth should be replaced.

### THE INTERNAL CAROTID ARTERY

May be exposed in the manner recommended in note.* This vessel is much larger than the external carotid

* I strongly recommend the following section of the cranium, which will give a very complete view of the terminating portion of the vertebral artery, and afterwards of the internal carotid and pharyngea ascendens artery, and of the eighth and ninth nerves in the upper part of the neck. The brain should first be removed in the usual way, leaving uninjured, however, the cerebellum, medulla oblongata and pons varoli. The tentorium should now be removed, and the cerebellum pushed gently forward, or a small portion of its posterior part removed, so as to make room for the saw. A vertical section of the cranium should be next made through the posterior part of the occipital foramen and through the cervical vertebræ, behind their articular processes. This section will enable us to study the medulla oblongata vertebral arteries and their branches, and the eighth, ninth, and suboccipital nerves, as exhibited in the plate at the end of this work. After these parts have been examined the cerebellum and spinal marrow may be removed, and the ligaments divided which connect the occipital bone to the first and second vertebræ. The vertebræ may now be separated from the occipital bone, the recti capitis antici having been previously detached from the front of the spine, but allowed to remain in connexion with the occipital bone. Lastly, the lower part of the neck may be cut across, and the digastric and styloid muscles, &c. neatly dissected. The portion of the internal carotid contained in the osseous canal must be carefully followed with a chizel and its exact relation to the Cochlea Tympanum and Eustachian tube may be seen in the metallic cast of the ear, or after softening the bone in a dilute acid.

in the young subject, but of nearly equal size in the adult. It usually arises opposite the superior margin of the thyroid cartilage, and ascends to the base of the cranium, being lodged superiorly in an angular space formed by the pterygoid muscles on the outside, and the superior constrictor of the pharynx on the inside. This may be termed

*Its first stage.*—In this course it constantly forms a curvature, the convexity of which looks outwards, and lies farther from the middle line of the neck than that of the external carotid. In the remainder of its ascent to the base of the skull it usually forms a number of other tortuosities seldom alike in any two subjects. *Its posterior surface* corresponds to the spine, rectus capitis anticus major muscle, and to the superior cervical ganglion, from which it is separated by the laryngeal (and usually by the pharyngeal) branch of the pneumogastric nerve. Near the base of the skull the internal jugular vein lies posterior and a little external to it, but separated from it by the hypo-glossal, glosso-pharyngeal and pneumogastric nerves immediately after their exit. *Its anterior surface* is covered inferiorly by the external carotid, from which it separated a little higher up by the stylo-glossus and stylo-pharyngeus muscles, the styloid process or stylo-hyoid ligament, a portion of the parotid gland, the glosso-pharyngeal nerve, and occasionally the pharyngeal branch of the pneumogastric nerve. Immediately before it pierces the base of the cranium its anterior surface is related to the Eustachian tube and origin of the levator palati muscle. *Its external surface* cor-

responds to the glosso-pharyngeal nerve, the styloid process, the origin of the stylo-pharyngeus muscle, an aponeurosis separating it from the parotid gland and to the jugular vein. *Its internal surface* corresponds to the pharynx and the pharyngea ascendens artery. The tonsil lies anterior and internal to it. In this stage it gives off no regular branches.

In the next part of its course, that is,

*In its second stage*, we trace it forwards and inwards through the carotid canal, surrounded as in the neck by filaments of the sympathetic nerve, and also by a few small veins that terminate in the cavernous sinus. In this canal it is situated anterior and internal to the cavity of the tympanum, (from which it is separated only by a thin partition of bone) and lies inferior to the cochlea and Eustachian tube. In passing through the temporal bone it sends a delicate branch to the tympanum, and afterwards a very minute branch to anastomose with the vidian artery. Having emerged from the carotid canal, it ascends through the cartilaginous substance, filling the foramen lacerum anterius or spheno-temporal fissure: here its second stage terminates.

*In the third stage* it advances through the cavernous sinus in the form of a Roman S, being first convex superiorly, and more in front convex inferiorly. It then pierces the dura mater, and immediately beneath the anterior clinoid process, makes a turn backwards and inwards, and terminates on the outside of the commissure of the optic nerve, and at the internal extremity of the fissure of Sylvius, by dividing into

the anterior and middle arteries of the cerebrum. As it passes through the cavernous sinus, it is crossed from behind forwards by the sixth nerve, which is closely applied to its external margin. A branch of the sympathetic nerve may also be observed to ascend on its outside and join the sixth nerve, after the latter has passed the carotid artery. More externally, and in the outer wall of the cavernous sinus are situated the third, fourth, and ophthalmic branch of the fifth nerve. When piercing the dura mater, the lining membrane of the sinus is reflected on it, forming a sheath that separates its coat from the blood of the sinus. In this third stage it gives off while in the cavernous sinus some small branches to the dura mater, and to the inferior petrosal sinus and pituitary body—also a branch to anastomose with the middle meningeal artery. Immediately after escaping from the cavernous sinus it gives off the ophthalmic artery, and still later the choroid and posterior communicating arteries. It then terminates by dividing as already observed into the anterior and middle arteries of the cerebrum.

*The Ophthalmic Artery*

Is given off beneath the anterior clinoid process, and may be exposed in the manner advised in the appendix. Immediately after its origin, it advances between the second and third nerves, and enters the optic foramen, being lodged in a fibrous sheath formed for it by the dura mater. At first it lies on the outside of the optic nerve, then ascends to get on its superior surface, where it is covered by the levator palpebræ and superior rectus muscles, and accompanied by the nasal

nerve; and, lastly, it runs horizontally forwards between the internal rectus and superior oblique muscles towards the internal angular process of the frontal bone, where it terminates by dividing into the nasal and frontal arteries, both of which escape from the orbit in company with the infra-trochleator nerve, in passing above the tendo oculi and beneath the pulley of the superior oblique muscle.

The ophthalmic artery gives off four sets of branches. 1st, on the outside of the optic nerve it gives off the lacrymal and central artery of the retina. 2dly, on the superior surface of the optic nerve it gives off the supra-orbital, ciliary, and muscular branches. 3dly, on the inside of the optic nerve it gives off the ethmoidal and palpebral—and, lastly, its terminating branches are the nasal and frontal.

*The Lacrymal Artery* is the first, and one of the largest branches of the ophthalmic: it passes forwards and outwards between the origin of the superior rectus muscle and the superior head of the external rectus. It supplies both these, and is conducted by the superior margin of the latter, towards the lacrymal gland: in this part of its course, it sends a branch through the malar bone into the temporal fossa, which anastomoses with the anterior deep temporal artery. More in front, it gives off a number of branches which pass above, and sometimes around the lacrymal gland to penetrate between its lobules and supply its interior. Lastly, the terminating branches are lost in the upper eyelid, in anastomosing with the internal palpebral and anterior temporal arteries.

*The Central Artery of the Retina*, extremely minute, pierces the coats of the optic nerve, and runs forward through its axis to arrive at the retina on the internal surface of which it forms a vascular expansion, which may be traced as far forwards as the ciliary processes. Immediately on escaping from the optic nerve, it gives off a branch, (*the Artery of Zinn*) which runs from behind forwards through the centre of the vitreous humor, to which it sends numerous small branches. In front it ramifies on the posterior part of the capsule of the lens, and in the fœtus its branches have been traced to the membrana pupillaris. This artery occasionally arises from one of the ciliary arteries.

*The Supra-orbital Artery* accompanies the nerve of the same name to the notch in the superior margin of the orbit. In this course it lies on the superior rectus and levator palpebræ muscles, beneath the periosteum, and on the inside of the supra-orbital nerve. It supplies the levator palpebræ and superior rectus muscles; and as it passes through the notch it gives a branch to the diploe of the frontal bone. It then divides into two principal branches, of which the internal is the larger. These subdivide into many others, which supply the occipito-frontalis muscle, and anastomose with the angular artery inferiorly, and with the temporal artery superiorly.

*The Ciliary Arteries* are classed into two sets—the short and the long. *The short Ciliary Arteries* (twenty, thirty, or sometimes even forty in number) advance tortuously through the fatty matter that envelopes the optic nerve, around which they form a vascular net-

work. After frequent anastomoses they penetrate the sclerotic coat, near the entrance of the optic nerve; some few of them terminate in this membrane, the rest proceed between the sclerotic and choroid coats. After forming by their frequent subdivisions and anastomoses a kind of vascular net-work on the exterior of the choroid, they pierce this membrane, and form a similar expansion on its interior. Having arrived at the ciliary body some of them merely pass through it to arrive at the great arterial circle of the iris, but by far the greatest number terminate in the ciliary body—each ciliary process receiving so many as twenty or thirty branches: these take a tortuous course in the substance of the processes, and then reuniting into larger and fewer branches, terminate behind the iris by anastomotic arches. In most cases several of these ciliary arteries come from some of the principal branches of the ophthalmic, and not directly from its trunk; and in every instance the muscular arteries give off several ciliary branches that have been termed *the anterior ciliary*. These pierce the anterior part of selerotic coat, and communicate with the preceding. *The long Ciliary Arteries*, usually two in number, pierce the selerotic coat a little in front of the short ciliary, and then run from behind forwards between the sclerotic and choroid coats—one on the inside, and the other on the outside of the eye. In this course they send a few delicate branches to the sclerotic coat, and still fewer to the choroid; and having arrived at the ciliary body they subdivide into many branches that communicate with the short ciliary ar-

teries, and form an arterial circle at the ciliary margin of the iris. From this circle arise many small branches that proceed towards the pupil in a radiated manner, and then bifurcate and anastomose with adjacent branches, so as to form a second arterial circle within the first.* From this second circle arise smaller and more numerous branches than from the first; these proceed in a radiated manner to the pupillary margin of the iris, where most of them enter into the formation of a third arterial circle within the two preceding. In the fœtus branches of the long ciliary arteries may be traced to the membrana pupillaris. In the operation of couching the needle should be made to penetrate the eye beneath its centre, in order to avoid these vessels.

*The Muscular Arteries* are usually two in number. The inferior is a large and constant branch. After its origin it passes forwards between the optio nerve and

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* "Much importance has been attached by anatomists to the manner in which these radiating vessels are disposed, in consequence of the representation of Ruysch, who exhibited them as forming a series of inosculations at a short distance from the pupil, since called the lesser circle of the iris. I do not deny that the vessels of the iris inosculate as in other parts of the body, but I do not believe that they present this very remarkable appearance, and I suspect that Ruysch exaggerated what he had seen, or described from an iris in which the injection had been extravasated and entangled in the tendinous cords, which I have described as extending from the fleshy bodies to the margin of the pupil. The question is fortunately of no importance. It is sufficient to know that the organ is amply supplied with arterial blood."—*Jacob in Todd's Cyclopædia.*

inferior rectus muscle. Its branches are distributed to this muscle, to the inferior oblique and external rectus muscles, and to the lacrymal sac. The superior muscular artery is smaller and less constant: its branches are principally distributed to the levator palpebræ and the superior and internal recti muscles; also to the superior oblique muscle, the globe of the eye and the periosteum of the orbit.

*The Ethmoidal Arteries* are two in number; they pass between the internal rectus and superior oblique muscle of the eye to arrive at the internal wall of the orbit. The posterior or larger enters the foramen orbitarium internum posterius, and sends several delicate branches to the membrane of the posterior ethmoidal cells: others enter the cranium and descend into the nasal fossa with the filaments of the olfactory nerve, to be lost on the mucous membrane of the nose. The anterior ethmoidal artery smaller than the preceding, accompanies the ethmoidal branch of the nasal nerve, and having entered the anterior internal orbitary foramen, is distributed to the mucous membrane of the frontal sinus, and of the anterior ethmoidal cells and nasal fossa. The posterior branch frequently arises from the lacrymal or supra-orbital.

*The Palpebral Arteries* are two in number; the inferior descends behind the tendo oculi, and after sending some twigs to the lacrymal sac, divides into two branches, one of which supplies the inferior division of the orbicularis oculi, while the other follows the adherent margin of the lower tarsal cartilage, and supplies this cartilage, the Meibomian glands, the con-

junctiva and skin. The superior palpebral arises a little more in front, and after supplying the caruncula lacrymalis is distributed in the upper lid, exactly as those of the inferior artery are in the lower eyelid. It anastomoses externally with the lacrymal and temporal arteries.

The terminating branches of the ophthalmic are the frontal and nasal.

*The Frontal Artery* usually smaller than the nasal, advances to the superior and internal part of the base of the orbit, from which it escapes in passing between the tendo oculi and pulley of the superior oblique muscle. It then ascends on the forehead, between the frontal bone and orbicularis palpebrarum, and subdivides to supply this muscle, and the occipito-frontalis and corrugator supercilii.

*The Nasal Artery* is larger than the preceding, and with it escapes from the orbit between the tendo oculi and pulley of the superior oblique muscle: it then descends on the side of the root of the nose, and supplies the lacrymal sac and adjacent muscles, and anastomoses with the termination of the labial or facial artery. In many cases the nasal artery seems to be perfectly continuous with the angular branch of the facial without any capillary intervention.

In the operation for extracting the eye the trunk of the ophthalmic is divided, and its sheath prevents it from retracting so as to bleed into the cavity of the cranium.

After the ophthalmic the next branch given off by the internal carotid is

*The Choroid Artery.*

This is a small but constant branch. It arises from the posterior part of the internal carotid, and passing backwards and outwards towards the crus cerebri, enters th inferior cornu of the lateral ventricle. It supplies the tractus opticus and crus cerebri, and its terminating branches are distributed on the choroid plexus.

*The Posterior Communicating Artery*

Sometimes arises before the preceding. It is a small but a constant branch. From its origin it takes a direction backwards and inwards to anastomose with the posterior artery of the cerebrum, which is a branch of the basilar trunk.

After giving off the posterior communicating artery, the internal carotid divides into two considerable branches, viz., the anterior and middle arteries of the cerebrum.

*The Anterior Artery of the Cerebrum*

Much smaller than the middle, passes forwards between the first and second cerebral nerves, to reach the great longitudinal fissure; it then ascends with that of the opposite side between the anterior lobes of the brain, and in front of the anterior part of the corpus callosum, along the upper surface of which it runs and descends behind it so as nearly to circumscribe this commissure. The branches, from its concavity, are small, and distributed to the corpus callosum; those from its convexity are more considerable and supply the internal surfaces of the hemispheres.

The anterior arteries of the cerebrum are united by one or two transverse branches that complete the circle of Willis in front; these are called the *anterior communicating branches;* when there is but one it is a large vessel; if more than one they are proportionably small.

### *The Middle Artery of the Cerebrum.*

The middle artery of the cerebrum from its size, might be considered the continued trunk of the internal carotid; it sinks into the fissure of Sylvius, taking a direction outwards and backwards. It first gives a great number of branches to the inferior part of the brain, to the pia mater covering the crura cerebri, and gives one or more choroid branches that accompany the choroid plexus into the inferior cornu of the lateral ventricle. It then divides in the fissure of Sylvius into two considerable branches for the anterior and middle lobes of the brain; these follow the fissure outwards and backwards, and terminate near the posterior part of the brain by numerous sub-divisions. Some tortuous twigs are given off which sink into the anfractuosities and supply the pia mater; others appear to perforate and surround the roots of the olfactory nerve.

*Anomalies of the Internal Carotid Artery and its Branches.*—I have already observed that the external carotid is sometimes deficient in which case the internal is a continuation of the common carotid, and gives off the branches that usually arise from the external—also that it sometimes arose near the base of the skull. In many cases we find that at the side of the

sella tursica it passes through a foramen formed by the existence of a middle clinoid process or spicula of bone connecting the tip of the anterior clinoid process to the side of the body of the sphenoïd bone. In some cases its anterior branch to the cerebrum unites with that of the opposite side, instead of being connected with it by one or more transverse branches, and after a short course the common trunk divides into two branches. Occasionally its posterior communicating branch is of considerable size, and its continuation forms the posterior artery of the cerebrum being connected to the basilar trunk by a short branch. Lastly, there are cases on record in which Haller had observed the two anterior arteries of the cerebrum furnished by the carotid of one side, and the two middle arteries of the cerebrum, furnished by the carotid of the opposite side.

In examining the course of the internal carotid artery, the student should impress on his memory the various important parts with which it is connected, and the manner in which it may be affected either by disease or accident, in consequence of its vicinity to them. Thus its relation to the tonsil points out the danger of directing the knife too deeply backwards or outwards in opening abscesses of that gland. Beclard relates a case in which an itinerant quack destroyed a patient's life in this way. The vicinity of this vessel to the organ of hearing explains the various derangements of the functions of the latter, arising in consequence of an undue determination of blood to the head, and the hæmorrhage which escapes from the ear in consequence of fractures extending to the base of the skull,

I am not aware that there is any case on record of aneurism of the trunk of the internal carotid, though its branches are frequently the seat of this disease. In one case, however, in which Sir A. Cooper operated successfully, he was of opinion that the disease was in this vessel and not in the external carotid.—*Medical and Chirurgical Transaction*, vol. i. p. 229.

I have already alluded to the peculiar plexus or rete mirabile found in the carotid arteries of certain animals and in the ophthalmic arteries of others. (See Introduction.)

## THE SUBCLAVIAN ARTERIES.

The subclavian arteries are two in number, a right and a left. The right subclavian arises from the arteria innominata, and the left from the arch of the aorta. Each subclavian artery is usually described as having three stages. In the first stage it ascends from its origin to the internal margin of the scalenus anticus muscle—in the second stage it passes behind that muscle, and in the third it proceeds obliquely downwards and outwards, till it arrives at the lower margin of the first rib, where it changes its name and becomes the axillary artery. In this course it forms an arch, the convexity of which looks upwards, and the summit of which is usually opposite to the sixth cervical vertebra. As they differ in their origins, their relations must necessarily differ in the first stage, and, therefore, a separate description will be necessary for each; but in the second and third stages their relations are exactly alike.

### *The first stage of the Right Subclavian Artery.*

The right subclavian artery arises from the arteria innominata behind the sterno-clavicular articulation, and passes obliquely upwards and outwards, till it reaches the internal margin of the scalenus anticus muscle. In this course it is covered *anteriorly* by the sterno-mastoid

### *The first stage of the Left Subclavian Artery.*

The left subclavian artery arises from the arch of the aorta opposite the second dorsal vertebra, and ascends slightly outwards into the neck, till it reaches the internal margin of the scalenus anticus muscle, where the second stage commences. In this course it is related—*internally* to the

muscle and cervical fascia, and more immediately by its corresponding vein, namely, the right vena innominata. Opposite the internal margin of the scalenus anticus muscle this vein is anterior, and a little inferior to the artery; lower down (on account of their difference of obliquity) they become more distant—the vein lying to the outside. In front of the artery we observe the superior and middle cardiac nerves descending; and also, near its origin the pneumogastric nerve and its recurrent branch. Consequently, these nerves separate the artery from the vein. *Posteriorly* the first stage of this vessel is related to the recurrent nerve, inferior cardiac nerve and vertebral vein, still farther back to the trunk of the sympathetic nerve, and longus colli muscle with the interposition of some loose cellular tissue. The cone of the pleura lies a little to its outside, and on a posterior plane.

origin of the left carotid artery, and to the œsophagus and thoracic duct; *externally* to the left lung and pleura; *anteriorly* its origin is crossed by the pneumogastric nerve, which in the cervical region lay on the inside of the artery. Higher up its outer edge, and part of its anterior surface, is overlapped by the pleura and lung—still higher, it is covered by the commencement of the vena innominata and vertebral vein, and at the internal margin of the scalenus anticus muscle, the phrenic nerve passing inwards towards the middle line, crosses the termination of this first stage. It may be also observed, that the thoracic duct frequently ascends on the front of this artery. *Posteriorly* this vessel corresponds to the spinal column, longus colli muscle, and inferior cervical ganglion.—(*See Plate representing the left subclavian in its first stage.*)

From the preceding account it follows, that the left subclavian artery differs in the following respects from

the right. The left subclavian is longer and proportionably slenderer; it arises lower down, and from the arch of the aorta; its direction is more vertical, and consequently more nearly parallel to that of the pneumogastric and phrenic nerves; it is intimately connected with the œsophagus and thoracic duct, and is covered in front by the pleura; lastly, its vein lies a little superior to it, while on the right side it is inferior to the artery.

*The Subclavian Arteries in their second stage.*

Each of the subclavian arteries in its second stage is covered *anteriorly* by the scalenus anticus muscle, which separates it from the phrenic nerve and subclavian vein, and is related *posteriorly* to the cone of the pleura and to the scalenus posticus muscle.

*The Subclavian Arteries in their third stage.*

Each of the subclavian arteries in its third stage takes a direction obliquely downwards and outwards, and having arrived at the lower margin of the first rib changes its name, and becomes the axillary artery. In this course it is covered *anteriorly* by the clavicle and subclavian muscle immediately above which it has other important relations, which we may now proceed to study. On raising the integuments, platysma and fascia, we usually observe a space between the trapezius muscle on the outside, and the sterno-mastoid on the inside: in some cases, however, the fibres of these muscles meet at their clavicular attachment, so that in order to expose the artery, it becomes necessary to

divide transversely some of the fibres of the trapezius; in the deeper layer or stratum we observe the posterior belly of the omo-hyoid muscle passing at first horizontally inwards, and then slightly upwards and inwards towards the larynx, so as to form with the external margin of the sterno-mastoid muscle, a triangular space bounded inferiorly by the clavicle. In this space the artery may be felt emerging from behind the scalenus anticus muscle. If we were to judge of the size of this space by the appearance it presents in the dissected subject, we would be led into great error. It is, in fact, hardly appreciable while the muscles that bound it preserve their natural relative position, though dissection may make it appear of considerable extent. The brachial plexus lies behind the artery, but a large portion of it projects at its acromial side. The vein is situated in a plane anterior to the artery, but inferior and nearer to the middle line. The anterior thoracic nerve descends in front of it in this first stage, and certain nervous filaments also descend from the brachial plexus, form loops round the artery and return to the plexus: lastly, it is crossed anteriorly by the transversalis humeri artery, which runs in this situation nearly parallel to the clavicle; such are the important anterior relations of this vessel. *Posteriorly* it rests on the inferior fasciculus of the brachial plexus, on the middle thoracic nerve, (which supplies the lesser pectoral muscle) and on the first rib.

*Anomalies.* In addition to the great number already noticed, I shall only add in this place, that in some cases the subclavian

vein passes behind the anterior scalenus along with the artery, and in other cases the artery passes in front of that muscle along with the vein.* Both these varieties have been observed by Velpeau. M. Robert has observed, that the little scalenus when present, in passing to its insertion into the rib, frequently separates the two inferior fasciculi of the brachial plexus, and pushes them forward against the artery. In some cases the sterno-hyoid muscle arises behind the sterno-mastoid; and in others, the omo-hyoid muscle has an additional origin from, or attachment to the clavicle.—(Velpeau, Hargrave.)

Bouillaud mentions that Breschet observed a very remarkable anomaly, in which the left subclavian artery arose from the pulmonary artery. In some cases the thyroid axis is deficient, and its usual branches arise by two or more separate trunks. In its third stage it often gives off the posterior scapular. Mr. Hargrave has seen the internal mammary arise in this situation, and descend in front of the scalenus anticus muscle.

### *Operation of tying the Right Subclavian Artery in its first stage.*

The patient is to be placed in the same position as for tying the arteria innominata. The first incision should commence immediately above the sternum, at the internal margin of the sterno-mastoid muscle, and be continued horizontally outward for the extent of about three inches; the second incision, about two inches long, should descend along the internal margin of the same muscle, so as to terminate inferiorly in the internal extremity of the preceding incision. The flap of integument thus formed is to be dissected up, and the lower part of the sterno-mastoid exposed. Behind this muscle a

* Hird. Lon. Med. Gazette, Feb. 4, 1837.

director is to be now introduced on which its sternal and part of its clavicular origin should be divided. In a similar way the origin of the sterno-hyoid, and then of the sterno-thyroid, should be cautiously divided on a director. By scraping through some cellular membrane, we may now get a view of the carotid artery, and by passing the finger between this vessel and the jugular vein, (which is situated more externally) the subclavian artery may be felt. It is crossed near its origin by the pneumogastric and recurrent nerves which must be drawn *inwards*, and the needle is to be carried round it from below upwards and inwards, on the inside of its vertebral branch. The cardiac filaments of the sympathetic nerve should be avoided, and the operator should bear in mind the vicinity of the cone of the pleura, as it may be wounded in performing this operation.

The operation of tying the right subclavian artery in the first part of its course has been three times performed; 1st, by Mr. Colles of Dublin; 2dly, by Mr. Hayden of Dublin; and 3dly, by Mr. O'Reilly of Dublin.

*Mr. Colles's Case.*

The ligature was put on the artery in October 1811, but not tightened (great dyspnea and oppression about the heart having occurred) till the 4th day. On the 9th day the patient complained of sense of strangling and pain about the heart. He then became delirious, and died in a few hours. (*Ed. Med. & Surg. J. Jan.* 1815.)

*Mr. Hayden's Case*

Occurred in 1835 (that is twenty-four years after Mr. Colles's). The following particulars are derived from the report of it in the Lancet, October 7, 1837. Eliza Moulang, aged 57, unmarried, and of intemperate habits, states, that in November 1834, she perceived a small pulsating tumor, of the size of a pea, about an

inch and a half below the right clavicle, and at an equal distance from the sternum. In April 1835, it had increased to the size of a marble, and was for the first time attended with pain, viz., of a lancinating character. This recurred at intervals till August, after which it remained permanently, being however attended with increased severity at intervals.

"August 22, 1835. She was seen by Dr. Ireland, Messrs. Wilmot, O'Beirne, and Hayden, for the first time.

"Sept. 7. The patient was admitted into the Anglesey Hospital. On examination, a large pulsating tumour was observed situated internally to the axilla, parallel to the upper edge of the pectoralis minor, and extending above the clavicle: it is circumscribed, and has pulsation referrible to its inferior part. There is considerable tension on the upper portion of the tumour, the size of which can be diminished by pressure. Comparing the clavicle of this side with the opposite one, the former appears somewhat displaced, being pushed upwards. The arm, forearm, and hand were much swollen and œdematous some days since, and 'Bruit de soufflet' was audible over the tumour.

"The results of stethoscopic examination not unfavourable in reference to operation for this disease which is declared to be aneurism of the subclavian artery extending to the *scalenus*. She now describes the pain as darting through the tumour to the back of the shoulder, and down to the elbow. She also complains of an almost insupportable sense of weight and numbness in the whole extremity, although the swelling of it is inconsiderable.

"From the 7th to the 15th of September, aperients, venesection, and anodynes were employed with only temporary alleviation of her sufferings.

"Consultations were held, at which some of the most eminent practitioners of this city gave their assistance. The operation at the distal side of the artery was mooted; but, ultimately it was decided, that the subclavian should be tied at the internal side of the scalenus, if that portion of the artery proved sound, and if not, to secure the arteria innominata. The sufferings from the aneurism were, at this time, very severe; and

dynes in immense doses had failed to procure even temporary ease.

"The patient, after a full statement of the grounds of our hopes and our fears, as to the result of the operation, expressed intense anxiety to submit to any measure which would afford even the slightest hope of removing her present almost intolerable sufferings, provided there was no probability of her expiring during the performance of the operation."

*Operation.*—On September 15, 1835, at three o'clock, P. M. Mr. Hayden, assisted by the consulting officers of the Hospital, proceeded to perform the operation in the following manner:—

"Patient placed on the back upon a large table, furnished with mattrass and bolsters; head slightly depressed, and turned to the left side. First incision, commenced nearly at the left sterno-clavicular articulation, traversed the upper margin of sternum and clavicle and terminated beyond the posterior or acromial margin of the sterno-mastoid muscle, having divided the integuments and platysma, including subjacent adipose tissue, of about a quarter of an inch in depth. Second incision, commenced about four inches above the sternum, a little to the left of the mesial line of the neck, so as to terminate by falling at right angles on the commencement of the first incision, dividing the parts to the same depth: two sides of a triangle were thus formed, the apex at the sternum. The flap, consisting of integument, platysma, and adispose layer, was raised from the apex upwards and outwards; the outline of the sterno-cleido-mastoid was now very distinct, but still covered by the superficial cervical fascia; the latter was carefully divided immediately above the sternum, corresponding to the anterior edge and lower extremity of the sternal portion of the sterno-cleido-mastoid. A director was next introduced beneath this muscle, the fibres of which were divided at about a quarter of an inch from the sternum and clavicle, and precisely parallel to its origin. The muscle was now raised upwards and outwards with the handle of a scalpel; a small vein was here tied. In the next stage of the operation, the sterno-hyoid and sterno-thyroid were divided upon a direc-

tor. Hæmorrhage from a small artery and vein so inundated the part, that it was found necessary to secure them before the operation was proceeded with. After the displacement of some cellular structure with a director, the innominata, carotid, and subclavian were felt; compression of the last mentioned vessel suspended pulsation at the wrist and tumour. The first part of the subclavian was found not involved in the disease, and, consequently, it was decided that this vessel should be tied in preference to the innominata, which had been clearly exposed, and which, from its direction, and being uninterfered with by the clavicle, seemed to offer much less obstacle to the passage of the ligature; this was, at first, attempted with an aneurism needle, made of silver, in order that it might be bent so as to present a degree of concavity to the clavicle, to be determined by the displacement of this bone, and the depth of the artery. The eyed part of the needle, for about an inch, was made to slide off and on (like the canula of a trocar), so that when the extremity of the needle was brought around the artery, the eyed portion, with the ligature, might be withdrawn. But when the handle of the instrument was depressed, the upper part slipped from the lower before the latter had passed under the artery. The vessel was subsequently secured with Mr. L'Estrange's needle. (See p. 17.)

"The surgeon's knot was made very readily in the usual manner; the middle and internal coats of the artery were felt giving way as the ligature was tightened, the extremities of which, having been brought over the clavicle, the flap was next laid down and retained by two points of suture, pledgets of lint, and adhesive plaster.

"Eight o'clock, P. M.—Immediately after the operation, the pulse in the left wrist was 124, and soft; respiration was somewhat oppressed, and became more so since, accompanied with partial loss of voice and difficulty of deglutition; felt an acute pain in the stomach after swallowing any fluid; considerable sense of tension in the neighbourhood of the wound:—tumour, which was considerably diminished, upon the application of the ligature, is now refilled, but, with an absence of pulsation; complains of

pain somewhat similar to that experienced before the operation; coldness of the right-hand, which was removed by the application of warm flannels."

The treatment adopted after the operation consisted of the measures proper for restoring the temperature of the limb, quieting the system with narcotics and moderating an attack of bronchitis. On the 19th, she was, to use her own expression, fine and easy: on the 25th, though positively forbidden, she got out of bed, and walked about the room.

"Subsequently at two o'clock, P. M., she would not suffer the nurse to pass the bed-pan under her, but got out of bed; while in the act of doing so, and rising upon her right hand, placed upon the bed, considerable hæmorrhage suddenly set in. Mr. Farnly (now Dr. Farnly, of Dewsbury, who was at that time a resident pupil at the hospital, and noted and kindly took charge of the case,) turned down the poultice, and thrust a piece of sponge into the wound; nearly a pint of blood had flowed almost in a continued stream over the clavicle, not florid as arterial blood, nor did it come per saltum. In consultation, it was agreed to remove the sponge, and introduce a fresh piece with a ligature attached. Upon removing the first sponge the coagulum formed was sufficient to resist further hæmorrhage, although she breathed laboriously, and coughed several times. The sponge, with the ligature attached, was then pushed a little way beneath the clavicle into the wound, a second piece placed over this, and finally, two or three compresses of lint were bound over both, with a figure of 8 bandage.

"27. Four o'clock, P. M. Hæmorrhage did not recur. Oppression and difficulty of breathing, with a quick and compressible pulse, have been present since last report, together with a sense of sinking. Involuntary discharges yesterday; mucous râle during the day. She expired about this hour without a struggle, retaining her senses to the last."

*Post mortem appearance about twenty-four hours after death.*—"On raising the parts concealing the loop of the ligature some coagulated blood was found in this situation. The surrounding

parts were all agglutinated by the effusion of lymph. The subclavian artery, at the site of the ligature, was gaping irregularly for three-fourths of its calibre, the remaining one-fourth sound and retaining the ligature. The right carotid *considerably* enlarged. The aneurism was found to extend to the anterior scalenus muscle, beneath the clavicle, and between the branches of the brachial plexus of nerves.

"Its contents were solid throughout, and laminated. A second aneurism, of the axillary artery, about the size of a large gooseberry, distinct from the former, was situated in the first stage of its course. The innominata was healthy; the arch of the aorta somewhat dilated; heart natural; acute bronchitis of both lungs."

Mr. Hayden after remarking, that in none of the three cases in which a ligature was put on the right subclavian in its first stage, was there any attempt at the reparative process in the site of the ligature as to render us sanguine of the result in pursuing this treatment again; and having also noticed the fact, that operations on the subclavian in its third stage have proved successful, though very near the site of the operation internal to the scalenus continues to observe:—

"Are we to look for the cause of this success in the circumstance of the *impetus of the blood sent from the heart* being taken off by the several branches (viz. vertebral, thyroid-axis, internal mammary, cervicalis profunda, superior intercostal), which come off from the artery at the cardiac side of the ligature? The want of success that has followed a ligature placed upon the A. innominata, would also go to show that the impetus of the blood has a great share in disturbing the sanative process set up by nature at the site of the ligature. Under these circumstances, I would suggest the propriety of tying both the common carotid and the subclavian at the *same time*; and the steps of the operation necessary for exposing the latter, will be sufficient for laying bare the former also. A coagulum will soon form, which will extend through the portions of subclavian and carotid on the cardiac side of the ligature, and also through the *whole* of the

arteria innominata. The carotid, not having any branch near to the distal side of the ligature, would be more secure than the subclavian; but we have seen that coagulation of the blood in the aneurismal tumours was *not* prevented by the reflected supply obtained from the branches intermediate between the ligature and the aneurism; and in the three cases, the common carotid of that side was open and *considerably* enlarged. Of course, this plan should be aided by the constitutional and local means known to favour coagulation of the blood in the sac of an aneurism. How favourable has been the termination of operations upon the carotid, femoral, and external iliac arteries. In each of these cases, the large vessel (subclavian, profunda, or internal iliac respectively) is at such a distance from the ligature as to permit the formation of a *lengthy* coagulum at the *cardiac* side of the ligature."

*Mr. O'Reilly's Case.*

Thomas Duffy, aged 39 years, a man of robust frame and 20 years employed as helper in a stable, was admitted into Jervis-street hospital, April 15, 1836, under the care of Mr. O'Reilly, for aneurism of the right subclavian artery. He has lived a life of sober intemperance, always drinking, but never incapable of attending to his duty. The aneurismal tumor was distinctly circumscribed, of a somewhat oval shape, and measuring in transverse diameter two inches and a half, and in the vertical direction two inches. The pulsation could be distinctly felt in all parts of the tumor, and pressure on the subclavian artery not only commanded the pulsation of the sac, but even diminished its contents to the degree of rendering it flaccid—finally, the bruit de souffle was distinctly audible over all its surface. The first time he observed this tumor was in February last, and since that time he thinks it has made little progress. The symptoms he complained of on admission were numbness of his fingers and uneasy sensations in his arm and forearm with occasional cramps since last Christmas. For the last eight or nine weeks he has been obliged to remain almost constantly in bed with his arm extended from his body as he suffered considerable pain

whenever he walked about for any time, or approached his arm to his side; in bed, however, with his arm extended he is quite free from pain. His general health did not seem impaired, and his heart and lungs were sound, judging from careful physical examination. On the whole he appeared to be a favourable subject for the operation which was decided on at consultation held with the hospital surgeons, the patient being informed of the nature and urgency of his symptoms, expressed his willingness to submit to any operation which would give him relief. Accordingly at two o'clock the following day (September 16) Mr. O'Reilly proceeded, with the assistance of his colleagues, to perform the operation.

*Operation*.—The patient being placed in Heurtelop's bed with his head slightly depressed and turned to the left side, so that the light of the sky-light might fall into the deep space in which the artery was embedded, Mr. O'Reilly commenced the operation in the following manner, standing by the patient's right side. He first drew down the integuments of the lower part of the neck over the clavicle with his left hand, and then cut freely on the bone, beginning his incision about the centre of the clavicular origin of the right sterno-mastoid muscle, and terminating it over the trachea opposite the centre of the sternal origin of the left sterno-mastoid muscle: this incision was about four inches in length. The next incision was made through the integuments along the internal margin of the right sterno-mastoid, and terminated inferiorly in the centre of the preceding incision; in the same line the superficial fascia and platysma were divided successively on a director. The sternal origin and internal half of the clavicular origin of the right sterno-mastoid muscle were divided tranversely close to the bone, and detached. On introducing the finger the line of the carotid artery could be distinguished, and its pulsations felt. The deep fascia was next divided and a little of the internal margins of the sterno-hyoid and sterno-thyroid muscles, so as to expose the carotid artery, the sheath of which was cautiously opened by pinching a small portion of it with a forceps, and dividing the raised portion of it

horizontally. A blunt silver instrument the size of a small scalpel with a round point, was used in the subsequent steps of the operation. The carotid artery being taken as a guide, the subclavian artery was easily exposed lying at the bottom of a very deep cavity. The jugular vein was drawn outwards by means of a curved spatula, and the pneumogastric nerve inwards by a similar instrument. Mr. L'Estrange's needle (see note, page 17) armed with a three-threaded ligature, was passed round the artery from below upwards with facility and without disturbing the artery in its situation. The ligature being tightened round the vessel, the edges of the wound were brought into contact, and retained so by two strips of adhesive plaister.* Three hours after the operation he felt comfortable and well in every respect, and heat and sensation were the same as in the opposite arm.

*2d day.*—The surgeon was informed that the patient had a restless night, complained of oppression and weight on his chest, His pulse 100, and his skin dry, but not very hot. V. S. ad ℥*xx*. ℞, Bicarb. sodæ ʒ*ij* Nitratis potassæ ℈*ij* Aquæ puræ ℥*vi* Mucilaginis Gum Arab. ℥*i* Syrupi Cort. Aurant. ℥*ss*. Tinct. Hyosciami Tinct. digitalis *ää* ʒ*ij M*. fiat. Sumat cochlearia ampla duo c uno succi limonis 3tia quâque horâ. Incipiat misturam past solutionem alvi Habeat statim enema purgativum.

*3d day.*—7 o'clock, A. M. had taken all the mixture, passed a good night, and perspired freely; pulse 102, right arm bathed in perspiration; tongue moist. Habeat Infus Rosæ c sulphat

* I was not myself present at this operation, but have been informed that it occupied only twenty-five minutes, and that not more than a teaspoonful of blood was lost. It also appears that though the theatre was excessively crowded, yet from the excellent arrangements that had been made, the great fortitude of the patient, and the admirable skill and coolness of the operator, not the slightest interruption or delay occurred from beginning to end. My account of the case is abridged from the notes of Surgeon Banon, a gentleman of considerable talent, on whose accuracy every reliance may be placed.—V. F.

Magnesiæ in vicibus partitis. Post alvi solutionem perstet in usu misturæ ut heri.

*4th day.*—8 o'clock, A. M. slept well; pulse soft and full; tongue clean and moist; bowels free. ℞ Bi-carbonatis sodæ ʒij Aquæ ʒviiss Syrupi Cort. Aurant. ʒss Tinct digitalis guttas xxxx Tinct. Hyosciami ʒi M. St. Cochlearia ampla duo cum uno succi limonis 3tia quâque horâ inter effervescentiam.

*5th day.*—1 o'clock, P. M. Has had rather a bad night, cough troublesome, expectorated a considerable quantity of adhesive mucus tinged with blood. Pulse 95, soft and compressible; breathing natural; bowels regular. Ordered a mixture containing Digitalis, Hyosciamus, and Nitre as on the 2d day.

*6th day.*—Slept well; expectoration less and not streaked with blood; cough less troublesome. Repete Mist. ut. heri.

*7th day.*—Passed a good night; no cough; pulse 90.

*8th day.*—Pulse 80; slept well. The wound was dressed this day, and found to have united except where the ligature hung out; no discharge.

*9th day.* (1st of May.)—Slept well, has a good appetite, no medicine ordered.

*13th day.*—Improved in every respect. Aneurismal tumor hardened and diminished in size, pulse 78 and soft—ordered to get flummery.

*14th day.*—At about 12 o'clock the nurse reported that the wound was bleeding, and on inspecting it, the lint was found soaked in blood. He seemed very much alarmed, pulse 80, breathing natural—a slight fulness in the line of the wound.

*15th day.*—No return of the bleeding during the day, but at half-past one o'clock on awakening, he cried out that he felt his chest wet—on examination it was found that he had lost about 12 or 14 oz. of blood. Pulse 102—very compressible—no swelling in the line of the wound.

*16th day.*—Feels recovered from the effects of the loss of blood—no distress of any kind.

*17th day.*—Felt tolerably well—no cough—ligature came away—no hæmorrhage—appetite good—allowed cold chicken broth.

18*th day*.—Continues as well as yesterday.

19*th day*.—Bled last night from the wound to the extent of 6 or 8 ounces. Pulse 100, and very compressible. At 9 o'clock a consultation was held and the propriety of tying the arteria innominata discussed and negatived. A piece of lint moistened with a paste of flour and white of egg was applied to the wound, to which when dry it adhered with great firmness. ℞ Acidi sulp. dilut. guttas *x*. Tinct. Hyosciami et Tinct. digitalis ää drachmam Aquæ puræ uncias quinque—Syrupi limonis uniam—Misce—Sumat Cochl. amp. duo tertiâ quâque horâ.

20*th day*.—No hæmorrhage—passed a good night.

21*st day*.—Slept well—appetite good—tongue clean—pulse 70.

22*d day*.—Hæmorrhage returned at twelve o'clock last night to the extent of about 6 ounces. Pulse 108—moderate pressure stopped the bleeding—breathing quick—cough troublesome—countenance sunken—violent pulsation at the wound—wound inflamed and painful to the touch.

23*d day*. (Sunday the 15th of May.)—Hæmorrhage occurred during the night at three and five o'clock to the extent of four or five ounces. At seven there was a frightful gush of blood, which it was impossible to restrain by pressure. The lips of the wound were completely separated by a coagulum of blood projecting between them. He gradually become insensible, and his body covered with perspiration. In this state he remained till three o'clock when he died.

*Post mortem examination sixteen hours after death*.—The surface of the body exsanguineous—lips of the wound everted and separated by a large coagulum. On opening the wound freely a quantity of grumous blood was found which amounted to at least twenty ounces, and passed down between the spine and apex of the right lung, and also extended upwards along the side of the trachea. The pleura was inflamed, and the carotid artery thickened and enlarged; the pneumogastric nerve also appeared enlarged. The divided extremities of the subclavian artery were patulous and separated nearly two inches by coagula—their edges were jagged and irregular, and there seemed not to have been the

slightest attempt at the reparative process. The distal end of the artery was of the natural size. External to the scalenus anticus there was a sudden enlargement of the artery or aneurismal swelling, which extended four inches to the commencement of the axillary artery. On its upper and outer surface were stretched the brachial nerves. About an inch from the commencement of the tumor the clavicle passed over it and made a depression in it. The arteria innominata was healthy and the heart natural—the trachea red externally, and pale internally, but filled with a frothy mucus. A small portion of the upper part of the lung was hepatized. Bronchitis of the right lung—left lung healthy—no effusion into the thorax. A second aneurism about an inch in diameter was found on the axillary artery in the first stage of its course.

*Operation of tying the left Subclavion Artery in its first stage.*

It has been generally considered impracticable to tie the left subclavian artery in its first stage for the following very weighty reasons. It extends scarcely the breadth of a ligature above the first rib, and then makes a short turn; it is, moreover, covered in front in this situation by the subclavian vein and phrenic nerve. Beneath this point its deep situation, and almost vertical direction, its parallelism to the carotid artery, and pneumogastric nerve, and its intimate connexion with the thoracic duct and pleura present a complication of difficulties almost, if not altogether, insurmountable. Velpeau, however, seems to have a different opinion: after accurately enumerating its various relations he goes on to observe—"It is important to note all these differences, as they shew us that it would be much less dangerous to apply a ligature here than on the right side, because, being placed at a

greater distance from the origin of the vessel, the adhesive clot would form without difficulty. It would likewise be easier in its execution, for the nerves do not cross it as on the right, but descend parallel to its direction into the chest, and might be readily separated. Nevertheless, it must be admitted, that almost all these advantages are counterbalanced by the greater depth and almost vertical direction of the artery."—Velpeau Trans. vol. i. p. 186; and farther on in page 191, he observes in allusion to Mr. Colles, "did not this surgeon exaggerate in saying this operation was impracticable on the left." The mode in which this artery can be safely got at in his opinion has been already described at page 18.

*Operation of tying the Subclavian Artery in its second stage.*

This operation is not practised in this country; both on account of its supposed difficulty and the dangerous consequences apprehended. The difficulty has, in my opinion, been greatly exaggerated; with moderate care the scalenus anticus muscle may be divided without injuring the jugular vein, phrenic nerve, or scapular branches of the thyroid axis, and the difficulty of avoiding the cone of the pleura is not much greater than in passing a ligature on the first stage of the subclavian; lastly, though it be not desirable to tie an artery so close to one of its branches, yet there is every reason to believe that the absence of a coagulum on the cardiac side of the ligature does not by any means preclude the possibility of success.* In the event

* Mr. Guthrie expresses himself on this subject in the following words:—"My observations have not led me to believe that a coagulum is absolutely necessary for the permanent closure of the artery, although it certainly assists in maintaining it." And to the same effect lower down, "I have so often seen large

of aneurism of the third stage of the subclavian of the left side there is no resource, but this or the distal operation. It was originally suggested by Dupuytren, and in the London Medical and Physical Journal, for November 1826, a case is related in which he performed it with success.

### *Operation of tying the Subclavian Artery in its third stage.*

The patient should be placed lying on a table of a convenient height, with the shoulders elevated, and so that the light may falls directly as possible on the part to be operated on. The first incision should commence at the external margin of the sterno-mastoid muscle, immediately above the clavicle, and be continued transversely outwards for the extent of about two inches and a half. The platysma-myoides and fascia may now be divided on a director to the same extent. Some operators prefer dividing these three layers at once by the pushing up the shoulder, and then cutting down on the clavicle; such an incision will of course be above the clavicle when the shoulder is again depressed in order to continue the operation. In many cases, however, of large aneurism, these motions of the shoulder would be impossible. The lips of the wound should now be separated by retractors, and

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arteries heal after division close up to the giving off of a considerable branch, that I consider them to be always capable of doing so, provided they are naturally sound." *See his work on the Arteries*, p. 161. I find, however, that Sir A. Cooper, has lately expressed himself very strongly of the opposite opinion. *See Lancet, October* 14, 1837.

any fibres of the trapezius muscle that advance beyond its outer angle, should be carefully divided on a director. The external jugular vein which now presents itself should be drawn to the sternal extremity of the wound. If, however, it should happen to lie more towards the acromial side, it should be drawn outward; lastly, if it cross the centre of the incision, or if there be a second external jugular in this situation it may be necessary to include it in two fine ligatures and divide the vessel between them. The plexus of veins which usually present themselves next are to be separated with the handle of the scalpel, but injured as little as possible, as the further steps of the operation will be considerably obscured by the blood thrown out. The omo-hyoid muscle may be observed a little above the clavicle, from which point it ascends obliquely upwards and inwards. In a case operated on by the late Mr. Todd, this muscle lay below the clavicle, and it became necessary to draw it up and divide it before the artery could be exposed. Connecting the margin of this muscle to the adjacent margin of the scalenus anticus a strong fascia will be found, through which the operator should cautiously tear with his nail. The finger may now be passed behind the outer margin of the scalenus anticus muscle, in order to search for the subclavian artery. It should be borne in mind that the transversalis humeri arteri lies nearly in front of the subclavian, passing horizontally either behind, or immediately above the clavicle; the circumstance of its smaller size and its crossing in front of the scalenus anticus muscle may assist to distinguish it. The difficulty,

however, has been found greater than would have been expected *a priori*, the artery when exposed frequently contracts, and its pulsation ceases, the margin of the scalenus anticus is rendered indistinct by its connexion with fascia, and the welling of blood, depth of the artery and alteration of the relative position of the parts by the aneurismal tumor present difficulties, that require the greatest presence of mind, judgment, and knowledge of anatomy on the part of the surgeon. It has been suggested, under these circumstances, to saw through the clavicle. The student will find in the note* Mr. Hargrave's observations on this subject:

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* "Is such practice, I again ask, justifiable on the living subject?—what additional injury is produced? A compound fracture of the clavicle is superadded, yet of the simplest kind, and inflicted in the least injurious manner, being effected by the division of the bone with a saw, and that in the most guarded way. Such is the lesion; what is gained? The patient, in place of remaining on the table from an hour to an hour and a half, (which has often occurred when the tumour is large,) or even longer, during which period he must suffer the greatest anxiety, may be only a fourth of that period under the operation, or even less. What a time saved: the vessel will be better secured, consequently less dread of hæmorrhage, also the risk of wounding the subclavian vein will be much diminished. If recovery ensues, the bone will unite by ossific matter. Even though union of this kind does not take place, we may rest confident, that such a consolidation of parts will be obtained as will allow of every ordinary use of the upper extremity after the operation. It is necessary to state, that the late Mr. Todd was opposed to this practice. In a conversation which I had with him on the propriety of this innovation, he observed, it was suggested to him in this operation to saw the clavicle, the delay in passing the needle was so great; he was prevented from complying with this advice, fearing that it made a part of the aneurismal parietes, as

they are entitled to the most serious consideration. Dupuytren recommends that some of the outer fibres of the scalenus anticus muscle should be divided, which can be easily effected without injuring the phrenic nerve.

The branches of the subclavian artery are similar on the right and left side, and are given off in the following order. In the first stage it gives off the vertebral, internal mammary and thyroid axis, and in the second stage the cervicalis profunda and superior intercostal. It seldom gives off any branch in its third stage: occasionally, however, the posterior scapular arises in this situation and pierces the brachial plexus to arrive at its destination. Mr. Hargrave has seen the internal mammary artery arise on the outside of the scalenus anticus muscle.

### *The Vertebral Artery*

May be divided into three stages. In the first it ascends almost vertically in the neck as high as the atlas, in the second it passes horizontally inwards, behind the condyle of the occipital bone, and in the third it passes obliquely upwards, forwards and inwards, on the side of the medulla oblongata.

*In its first stage* it arises from the subclavian artery, a little on the outside of the carotid, and passes up-

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it was actually buried in the tumour. He further remarked, from the success attendant on his operation, he did not conceive it was ever called for. Though condemned by so good an authority, I still throw it out for consideration."—(*Operative Surgery*, p. 44.)

wards and backwards in the angular space formed between the scalenus anticus and longus colli muscles. In this course it lies on the inferior cervical ganglion, and is covered in front by its corresponding vein, and by the inferior thyroid artery which crosses its course and separates it from the common carotid. It then enters the foramen in the transverse process of the sixth cervical vertebra, and of those above it. In this course it ascends between the anterior and posterior intertransverse muscles, and in front of the anterior branches of the cervical nerves, along each of which it sends a small artery to the spinal marrow. It also gives off some muscular branches in its course, and anastomoses with the cervicalis superficialis and ascendens colli arteries. After the vertebral artery has passed through the foramen in the transverse process of the second vertebra, it inclines upwards and outwards, to reach that of the atlas, making a curvature, the convexity of which looks downwards, backwards, and outwards.

*In its second stage* it is horizontal. Directed at first backwards and inwards, it then winds forward and inward to pierce the posterior occipito-atloidean ligament. In this course—*its concavity* turned forwards, embraces the condyle of the occipital bone;—*its convexity* turned backwards may be seen in a triangular space, the base of which is formed on the middle line by the rectus capitis posticus major muscle, and the sides by the superior and inferior obliqui capitis. *Inferiorly* it lies in a groove on the posterior arch of the atlas, with the interposition of the ganglion of the

suboccipital nerve, and *superiorly* it is covered by a production of the posterior occipito-atloidean ligament which converts the groove for it into a canal.

*In its third stage** the vertebral artery pierces the dura mater beneath the insertion of the first tooth of the ligamentum dentatum, passes upwards and inwards on the front of this ligament, (which, consequently, separates it from the spinal accessory nerve, which is passing upwards and outwards behind it) then passes either before or through the midst of the fibrils composing the ninth nerve, applies itself to the side of the medulla oblongata, and afterwards getting in front of this body, joins the vertebral of the opposite side at the posterior margin of the pons, and forms *the basilar trunk.* The branches of the vertebral before their junction are the spinal arteries and one (or some times both) of the inferior arteries of the cerebellum.

The *posterior spinal artery* inclines downwards and inwards to get behind the spinal marrow, and descends parallel to that of the opposite side, as far as the second lumbar vertebra. In this course it anastomoses with those branches of the vertebral and ascendens colli, that enter the spinal foramina and with that of the opposite side, and sends many branches to the pia mater, and some delicate capillary branches to the spinal marrow: this artery is sometimes a branch of the inferior artery of the cerebellum.

The *anterior spinal artery* arises from the vertebral near its termination (sometimes from the inferior artery

* See Plate and accompanying explanation.

of the cerebellum, or even from the basilar trunk) It descends in a tortuous manner, and unites with that of the opposite side at the anterior margin the foramen magnum, so as to form a single trunk larger than either of the posterior spinal arteries: this common trunk descends in a tortuous manner, in front of the spinal marrow, below which it is prolonged without subdividing through the centre of the cauda equina, till it reaches the sacro-coccygean articulation, and here it terminates in anastomosing with the sacral arteries. In this course it gives off branches in every respect, analogous to those of the posterior spinal. It may be observed, that as the vertebral arteries converge superiorly to form the basilar trunk, and the anterior spinal arteries converge inferiorly to form a common trunk, the four arteries necessarily include a lozenge-shaped space in front of the medulla oblongata.

The next branch of the vertebral is the inferior artery of the cerebellum, but as on one side this vessel usually comes from the basilar trunk, I shall defer the examination of either branches till this trunk has been first described.

### THE BASILAR TRUNK.

Formed by the union of the two vertebral arteries proceeds from behind forwards on the middle line, between the nerves of the sixth pair, one of which lies on each side, having the cuneiform process of the occipital bone beneath it, and the pons Varoli or great commissure of the cerebellum above it. In this course it gives off a few small branches to the pons Varoli, and

usually one of the inferior arteries of the cerebellum as already observed. At the anterior margin of the pons Varoli it divides into four branches; two for the right side, viz. the superior artery of the cerebellum and the posterior artery of the cerebrum; and two similar arteries for the left side.

*The inferior Artery of the Cerebellum*

Generally comes on one side from the vertebral artery, and on the other from the basilar trunk: both, however, though rarely, may come from the vertebral, or still more rarely, both may arise from the basilar. After its origin it takes a direction outwards, (crossing in front of the pyramidal body when it arises from the vertebral, or either above or below the sixth nerve, when it arises from the basilar) it then passes backwards between the pneumogastric and spinal accessory nerves to the inferior surface of the cerebellum. Its first branches (very small) are distributed to the superior extremity of the spinal marrow, the origins of the eighth and ninth nerves, and to the fourth ventricle, and to the inferior surface of the cerebellum; the last, more considerable, creep along the inferior surface of the hemisphere to its circumference, where they communicate with the superior artery of the cerebellum.

*The superior Artery of the Cerebellum*

Winds round the crus cerebri, accompanying the posterior artery of the cerebrum, from which it is separated; first, by the third nerve; next, by the fourth; and lastly, by the tentorium. Having reached the superior surface

of the cerebellum, it divides into a great number of branches, some of which pass over the tentorium to the inferior surface of the brain; but the greater number under the tentorium to the superior surface of the cerebellum, where, after minutely subdividing, they are distributed to the pia mater, and anastomose with the branches of the inferior artery of the cerebellum. In this course it supplies the pons varoli, crus cerebri, tubercula quadrugemina, pineal gland, velum interpositum, choroid plexus, and the valve of Vieussens: one branch of it may be observed to enter the internal auditory foramen, separating the facial from the auditory nerve.

*The Posterior Artery of the Cerebrum*

Is much larger than the superior artery of the cerebellum: at its origin the third nerve hooks round it. It first proceeds forwards and outwards, then turns backwards and upwards, so as to wind round the crus cerebri: finally, it passes above the tentorium to arrive at the inferior surface of the posterior lobe of the cerebrum, to which it sends numerous branches that first ramify in the pia mater and afterwards penetrate its substance. Immediately after its origin it gives off several small twigs, some of which pass through the locus perforatus into the third ventricle, while others are distributed on the crura cerebri, corpora albicantia and tuber cinereum. Where it begins to curve backwards it receives the posterior communicating branch of the internal carotid. Immediately afterwards it gives off *a choroid branch*, which curves round the

crus cerebelli, and supplies the choroid plexus, velum interpositum and tubercula quadrugemina. Lastly, it gives off a small but constant branch that supplies the fascia dentata.

It may be remarked, that where the vertebral artery ascends through vertebræ that have little motion on themselves it presents no tortuosity, but in the superior part of the neck it makes a double curve,—first between axis and atlas, and then between the atlas and occipital bone in order to escape injury;—for in this manner in passing from one of these bones to another, it has twice the length of their vertical distance, therefore, as Mr. Mayo observes, the artery is only unbent, not stretched, in the more extensive motion of these bones. The vertebral artery has been known to be torn in fractures through the base of the skull.

The next branches of the subclavian artery are the internal mammary and thyroid axis, both of which arise opposite the internal margin of the scalenus anticus muscle, the former from its upper and the latter from its lower margin.

### *The Internal Mammary Artery*

May be exposed in the manner recommended in the note,* it arises from the subclavian opposite to the origin of the thyroid axis, and therefore at the internal margin of the scalenus anticus muscle. It descends

* In order to expose the trunk of this artery it is only necessary to cut through and remove the costal cartilages and intercostal muscles that cover it, and to saw through the clavicle or disarticulate it from the sternum. It is then easy to follow its external and terminating branches, and the internal may be examined after opening the thorax.

obliquely forwards and inwards, lying on the anterior scalenus muscle, covered by the vena innominata and sterno-cleido mastoid, and parallel to the phrenic nerve which lies on its outer side. It then descends into the thorax between the pleura and costal cartilages being separated from the latter by the phrenic nerve crossing it from without inwards. Lower down the internal mammary artery descends between the triangularis sterni muscle (which separates it from the pleura) and the costal cartilages, and internal intercostal muscles which lie in front of it. Having arrived at the cartilage of the seventh rib it terminates by dividing into an internal and external branch. In this course it is about a finger-breadth distant from the sternum. From its origin to the third cartilage, it is inclined inwards, but in the rest of its course its direction is outwards. Its branches are classed into the internal, external, and terminating.

*The Internal Branches* are distributed to the thymus gland, the sterno-hyoid and sterno-thyroid muscles; the adjacent lymphatic glands, and the cellular tissue of the anterior mediastinum.* A remarkable and constant one termed the *comes nervi phrenici*, accompanies the phrenic nerve in a tortuous manner, supplying as it descends the thymus gland and mediastinum the pericardium, pulmonary veins, and internal surface of the lung; after which its terminating branches are lost in supplying the diaphragm and in anastomosis with the subphrenic branches of the abdominal aorta.

* The branch to the anterior mediastinum is occasionally a direct branch from the arch of the aorta.

*The external Branches* correspond to the intercostal spaces, each of which receives one, or, in some cases, two. They will be found larger and longer the lower they are examined. When there is one for each space, it proceeds along the inferior margin of the corresponding rib. If there be two, one passes through the upper and the other through the lower part of the intercostal space. In all cases they supply the intercostal muscles, and communicate with the proper intercostal arteries; some of them pierce these muscles, and supply the pectoral muscles, mammary gland, and integuments.

*The terminating Branches* are two in number; viz. an external and internal. *The external* or musculophrenic branch descends obliquely outwards, behind the inferior costal cartilages, and having passed through the diaphragm, into which it sends some twigs, terminates in supplying the transverse and oblique muscles of the abdomen, and in communicating with the circumflexa ilii, lumbar, and inferior intercostal arteries. *The internal* terminating branch communicates with that of the opposite side at the ensiform cartilage, and then descends between the posterior surface of the rectus muscle and its sheath. After sending some twigs to this muscle, and others that pierce its sheath to arrive at the broad muscles of the abdomen, it divides near the umbilicus into many branches that anastomose with the epigastric artery.

This anastomosis was at one time supposed to be the cause of the sympathy between the mammary gland and the uterus.

The internal mammary artery may arise from the arch of the

aorta, arteria innominata, thyroid axis, and even from the third stage of the subclavian, as observed by Mr. Hargrave. Bichat has seen its comes nervi phrenici branch as large as the trunk of the internal mammary, and Cruveilhier met a subject in which its third intercostal branch was large enough to appear a bifurcation of it.

### *The Thyroid Axis.*

This short trunk arises from the subclavian artery, close to the internal margin of the scalenus anticus muscle, and opposite to the origin of the internal mammary artery. Its branches, which arise immediately after its origin, are three in number; viz. the inferior thyroid, superior scapular, and posterior scapular.

1. *The inferior Thyroid Artery* first ascends a little, and then turns inwards behind the jugular vein, pneumogastric nerve, and carotid artery; all of which it curves slightly to embrace; its convexity being turned backwards towards the vertebral artery, which it consequently separates from the carotid. The trunk of the sympathetic nerve usually descends on the front of this vessel, forming on the right side a small ganglion (the middle cervical) which lies on the anterior surface of the artery; in other and rarer cases the sympathetic nerve descends behind it. As the inferior thyroid artery approaches the thyroid gland, it forms another slight curve, the concavity of which looks backwards, and corresponds to the recurrent nerve, which a little further on passes between its terminating branches, particularly on the right side; on left side we find that, in addition to the preceding relations, the inferior thyroid artery lies on the œsophagus, and is

intimately connected with the thoracic duct, which usually ascends behind it, and makes an arch to terminate in front of it. The branches of the inferior thyroid artery are classed into the inferior, superior, and terminating.

*The inferior Branches* are variable in number; they descend into the chest, supply the œsophagus, longus colli muscle, bronchial tubes and glands, and anastomose with the superior intercostal and bronchial arteries.

*The superior Branches* are distributed to the longus colli and anterior scalenus muscles. One of them is constant, and, though usually small, is sometimes of considerable size; it is termed *the ascendens colli;* it ascends on the front of the scalenus anticus muscle, parallel and internal to the phrenic nerve. Its branches are distributed to the muscles on the front of the vertebral column; some of them inosculate with descending branches of the occipital artery, and others penetrate the lateral foramina of the spine to communicate with branches of the vertebral. The ascendens colli often comes off directly from the thyroid axis.

The operation of tying one or more of the thyroid arteries has been performed with a view to diminish the size of a bronchocele, or previous to extirpation of the thyroid gland. The inferior thyroid artery may be exposed by laying bare the sheath of the carotid artery in the manner already recommended, and drawing it to the external side. When this has been done, the inferior thyroid artery may be discovered crossing inwards, opposite (in most cases) to the fifth cervical vertebra; and care will be necessary to avoid the recurrent and sympathetic nerves on both sides, and the thoracic duct on the left side.

The inferior thyroid artery of the left side is particularly interested in performing the operation of œsophagotomy.

2. *The supra-scapular Artery* proceeds horizontally outwards, in front of the anterior scalenus muscle, the phrenic nerve, the brachial plexus, and the posterior scalenus muscle, being covered anteriorly by the clavicle and the sterno-mastoid and trapezius muscles. In this course it gives off a thoracic and acromial branch, and then passes over the ligament of the notch, in the superior border of the scapula, to arrive in the supra-spinata fossa, and terminate by dividing into the supra-spinata and infra-spinata artery. The nerve corresponding to the supra-scapular artery usually passes under the ligament of the notch. Sometimes, however, we find their position reversed, the artery passing beneath and the nerve above the ligament, or both may go together beneath it. *The Thoracic Branch* is small; it descends through the substance of the subclavian muscle, to communicate with the thoracic branches of the axillary artery. *The Acromial Branch* is considerable; it usually arises from the supra-scapular, as it is passing into the supra-spinata fossa, but may arise from it in any part of its course; it supplies the trapezius and supra-spinatus muscles and the periosteum and integuments covering the acromion process. *The supra-spinata Artery* is entirely lost in the muscle of the same name. *The infra-spinata Artery* descends in front of the spine of the scapula and beneath the spino-glenoid ligament.* Having arrived in the infra-spinata fossa,

* By the spino-glenoid ligament is meant a thickened portion

it supplies the muscles of this region, curves to anastomose with the inferior scapular artery, and sends a delicate branch along the axillary margin of the scapula to anastomose with the posterior scapular.

3. *The posterior Scapular Artery*, or transversalis colli, larger than the supra-scapular, passes horizontally outwards over the anterior scalenus muscle and phrenic nerve, then over the upper part of the brachial plexus and posterior scalenus muscle, to arrive at the superior angle of the scapula. In this course it is covered by the sterno-mastoid and trapezius muscles. Under cover of this last muscle it gives off the *Cervicalis superficialis*, which ascends on the back of the neck, supplies the splenius and trapezius muscles and the integuments and lymphatic glands, and anastomoses superiorly with descending branches of the occipital artery. Having arrived at the superior angle of the scapula, the posterior scapular artery gets under cover of the levator anguli scapulæ muscle, to which it sends a few small vessels, and divides into two branches of nearly equal size; one of which descends along the vertebral margin of the scapula, covered by the rhomboid muscles and levator anguli scapulæ, to each of which and to the serrati and latissimus dorsi it sends a supply. The other branch descends more externally, being covered by the scapula, and supplies the subscapular muscle and serratus anticus.

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of the cellular membrane that separates the supra-spinatus and infra-spinatus muscles external to the spine of the scapula. It was originally described by Sir A. Cooper.

In the second part of its course, while under cover of the scalenus anticus muscle, the subclavian artery gives off the cervicalis profunda and superior intercostal arteries, which frequently arise from it by a common trunk.

### *The Cervicalis Profunda*

Is a small branch that passes backwards through the brachial plexus, and between the transverse process of the seventh cervical vertebra and first rib.* It then ascends on the back of the neck, in the groove between the spinous and transverse processes of the cervical vertebræ, lying on the spino-transverse muscle, and covered by the great complexus. It supplies the deep-seated muscles on the back of the neck, and anastomoses with the vertebral and occipital arteries.

### *The Superior Intercostal Artery*

Inclines a little backwards, and descends into the thorax, having behind it the neck of the first rib, and the first dorsal nerve, as the latter ascends from the thorax. In front it is covered by the pleura, and on the inside it is separated from the margin of the longus colli muscle by the first thoracic ganglion. It then in many, if not in most, cases goes out of the thorax, in passing between the first and second ribs, and re-enters between the second and third. This artery gives off the intercostals of the first and second, and

* When there is a cervical rib, it passes between this rib and the first dorsal.

sometimes of the third, or more intercostal spaces, and sends a small branch inferiorly to communicate with the first aortic intercostal.

The branch to the first intercostal space is always small, and sometimes deficient.

I may observe, before concluding the subject of the subclavian artery, that I omitted in page 86. to mention that Mr. Ramsden was the first surgeon that succeeded in passing a ligature round this vessel in its third stage; Mr. Post, of New York, was the first that tied it with success, and Mr. Liston first tied it in Great Britain.

In operations on the axillary artery and about the shoulder, it may be necessary to compress the subclavian artery; and the profession are generally agreed, notwithstanding all Mr. John Bell has said to the contrary, that this can be readily effected by pressure against the first rib, above the clavicle.

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## THE AXILLA CONSIDERED GENERALLY.

The axilla has the form of a three-sided pyramid, *the apex* of which is turned upwards and inwards, and communicates with the neck, in the space between the scapula, clavicle, and first rib. *The base* turned downwards and outwards presents the excavation termed the arm-pit. By abducting the arm, the concavity of the surface may be diminished, but certainly cannot be rendered convex, as some writers represent. *The anterior wall* is formed by the greater and lesser pectoral muscles; *the posterior wall* by the subscapular muscle, and by the teres major and latissimus dorsi; and *the internal wall* by the thorax, intercostal muscles, and serratus magnus anticus. The anterior

and posterior walls are united by a strong fascia, which constitutes the base of this cavity, and may be exposed by raising the integuments. Externally the fascia is continuous with the aponeurosis covering the inside of the arm; and internally it is lost on the muscles of the thorax. We usually find it strengthened by firm narrow tendinous bands passing from the anterior to the posterior fold of the axilla, and occasionally there may be observed muscular bands taking the same direction: several authors describe them; and Mr. Lucas, lately, in a paper on the Anomalies of the Muscular System (Lancet, Sept. 22. 1838). The student may now abduct the arm, and remove this membrane, in order to examine the contents of the axilla. The muscles and the great axillary vessels and nerves descend externally along the humerus, the vein being most superficial: a large artery (the thoracica longa) may be felt descending behind the lower margin of the pectoralis major: and another (the inferior scapular) along the lower margin of the subscapularis muscle. When the arm is very much abducted, this last-mentioned artery has its direction altered so as to make it nearly parallel with the axillary artery, for which it may possibly be mistaken. From this account it is evident, that if we proceed to extirpate diseased glands from the axilla, we should cut towards the thorax; as, in every other direction, we encounter important vessels.

*The Lymphatic Glands* found in the axilla are classed into two sets; a superficial set, which are found along the inferior margins of the axillary folds; and a deeper set, that accompany the great vessels.

In the advanced stages of cancer, we find these glands enlarged and hardened, as also those along the outer edge of the sternum, and above the clavicle.

We may now proceed with the dissection, and raise the integuments, and some fibres of the platysma myoides, covering the anterior wall of the axilla. The great pectoral muscle, thus exposed, has two sets of origins,—one from the clavicle, and the other from the thorax; and these are separated by a cellular interval, in which the continental surgeons propose to make their incision, for coming down on the axillary artery in its first stage. The outer edge of this muscle is separated from the deltoid by another cellular interval, which contains the cephalic vein and the musculo-humeraria artery. More externally, but not forming a part of the anterior wall of the axilla, we observe a rounded prominence corresponding to the head of the humerus, and covered by the deltoid muscle. A little internal to this (and also covered by the deltoid muscle) may be felt the coracoid process, between which and the head of the humerus Lisfranc proposed to sink the knife, for the purpose of amputating at the shoulder-joint.

On raising the pectoralis major, we bring into view the thoracica longa artery, which was concealed by its lower border; also the pectoralis minor muscle, which contracts as it passes upwards and outwards, to be inserted under cover of the deltoid muscle into the coracoid process of the scapula. You may observe that the cephalic vein ascends in front of this muscle,

and the axillary vein behind it, and that they unite opposite its superior margin. Corresponding to the upper edge of the muscle you also find the acromial axis or artery, which separates it from the subclavian muscle and costo-coracoid ligament.* You may now detach the origin of this muscle from the thorax, and you will observe, on reflecting it outwards, a neat slender nerve (the middle thoracic) entering its posterior surface. The contents of the axilla are now brought fully into view. Externally we observe descending along the humerus the biceps and coracobrachialis muscles; more internally the axillary artery, with its accompanying vein and the brachial plexus. Two nerves cross the axilla, from within outwards, to reach the arm: these are the nerves of Wrisberg; they are branches of the second and third intercostal nerves, the superior being the larger. Lastly, far back we observe the long posterior thoracic nerve, descending behind the axillary vessels, on the cutaneous or scapular surface of the serratus magnus anticus muscle: this is the inferior external respiratory nerve of Bell. These parts, in addition to the lymphatic glands and cellular tissue already noticed, form the contents of the axilla.

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* The continental anatomists describe this merely as a slip of fascia. It extends from the coracoid process to the cartilage of the first rib. Its upper margin is attached to the clavicle; and the inferior, which is lunated, looks downwards and inwards. In front it is covered by the great pectoral muscle, and posteriorly lies on the subclavian. It is also called *the ligamentum bicorne.*

## The Axillary Artery

Commences at the lower margin of the first rib, and proceeds obliquely, downwards, backwards, and outwards, to terminate opposite the lower margin of the tendon of the teres major and latissimus dorsi muscles. In this course it is situated deeper above than below, and forms, when the elbow is brought to the side, a slight curvature, the convexity of which is turned outwards. It is usually described as having three stages: in the first it is above the pectoralis minor, in the second stage behind it, and in the third stage beneath it. *Anteriorly*, the axillary artery is covered by the anterior thoracic and median nerves, and by the pectoralis major muscle, from which it is separated in its first stage by the costo-coracoid ligament*, in the second stage by the pectoralis minor, and in the lower part of the third stage by the coraco-brachialis muscle. *Posteriorly*, it rests in the first stage on the first intercostal muscle, and corresponds (with the interposition of some cellular tissue) to the origin which the first slip of the serratus magnus anticus has from the second rib; in the second stage it corresponds to cellular tissue filling the interval between the last-mentioned relations and the subscapularis muscle; lastly, in the third stage it rests on the tendon of the subscapularis and the teres major and latissimus dorsi muscles. *Externally*, it is related to the brachial

* See note, page 106.

plexus, the insertion of the subscapularis muscle and the external cutaneous nerve. *Internally*, it is bordered by the axillary vein, which gets more on the front of the artery as it descends, and corresponds to the two first ribs, and serratus anticus muscle. In the first stage the brachial plexus is above and external to the artery; in the second stage the termination or apex of the plexus forms a complete sheath around it, and in the third it has the branches of the plexus arranged around it in the following order: viz. in front and crossing slightly to its outside is the median nerve, and one or two slips uniting its roots; on the outside are the external cutaneous nerve and external head of the median; on the inside the internal head of the median and the internal cutaneous nerve lying on the ulnar, and posteriorly the musculo-spiral and circumflex nerves.

*The Acromial Artery* is a short thick axis that arises a little below the clavicle and projects forwards above the edge of the pectoralis minor muscle, which it separates from the subclavian muscle and ligamentum bicorne.* It then advances towards the interval between the deltoid and pectoralis major muscles, and after sending some branches to the serratus magnus, pectoral and subclavian muscles, terminates by dividing into a superior and inferior branch. *The superior branch* passes horizontally outwards beneath the deltoid muscle, and is lost in supplying the latter and the

* See note, page 106.

supra-spinatus muscle, and the scapulo-humeral and acromio-clavicular articulations. *The inferior branch* (or thoracica-humeraria) turns spirally round the cephalic vein, and descends with it in the cellular interval between the deltoid and great pectoral muscles, and is distributed to these muscles and to the integuments. The acromial artery anastomoses with the supra-scapular and posterior circumflex.

*The thoracica suprema Artery* sometimes arises separately from the axillary artery a little beneath the preceding, but more frequently it is a branch of the acromial. It descends obliquely inwards between the pectoral muscles, to which it sends several branches. It also supplies the mammary gland and integuments, and anastomoses with the intercostal and internal mammary arteries.

*The Alar Artery* is seldom found as a single trunk, its place being usually supplied by several smaller vessels. It divides into many branches that supply the cellular tissue and glands of the axilla.

In removing diseased glands from this cavity, the incautious division of the alar vessels may be followed by smart hæmorrhage, which will be difficult to control on account of the divided vessels retracting into the cellular tissue. To provide against this occurrence Mr. Colles advises a ligature to be passed round the vessel supplying the gland before it is divided.

*The thoracica longa*, or external mammary artery, arises opposite the lower margin of the pectoralis minor and then descends obliquely inwards, concealed by the lower edge of the pectoralis major. It supplies these

muscles, and likewise the serratus anticus, intercostals, mammary gland, and integuments, and anastomoses with the other thoracic, the mammary, and the intercostal arteries.

*The Infra-scapular Artery* is of considerable size. It arises opposite the inferior margin of the subscapular muscle, to which it sends one or two branches, and then descends along its inferior margin till it reaches the internal edge of the long head of the triceps. Here it divides into an inferior and posterior branch: *the inferior branch* continues in the direction of the trunk, and descends between the serratus magnus and latissimus dorsi muscles, to both of which, and to the teres major, its branches are distributed. At the inferior angle of the scapula it anastomoses with the posterior scapular artery. *The posterior branch*, larger than the inferior, sinks into a triangular space, bounded above by the teres minor and subscapular muscles, below by the teres major and latissimus dorsi, and externally by the long head of the triceps, which, in this situation, separates it from the posterior circumflex artery. This branch supplies freely the muscles bounding this triangular space, and then curves round the axillary margin of the scapula to arrive in the fossa infraspinata, where it is covered by the teres minor. Here it divides into many branches, that supply the infra-spinatus muscle and shoulder-joint, and anastomose with the posterior and superior scapular arteries.

*Varieties.*—This artery sometimes arises in common with the following, and Dr. Monro has seen it arising from the inferior thyroid. Outlines of Anat. vol. iii.

*The Posterior circumflex Artery* is a little smaller than the preceding vessel, and arises close to it from the posterior part of the axillary artery. Immediately after its origin it sinks into a quadrangular space, bounded above by the subscapular and teres minor muscles, inferiorly by the tendons of the teres major and latissimus dorsi, anteriorly by the humerus, and posteriorly by the long head of the triceps. In passing through this space it winds round the surgical neck of the humerus, accompanied by the posterior circumflex nerve. After giving a few branches to the teres minor and subscapularis muscles, and to the shoulder-joint, it sinks beneath the deltoid muscle, into which it sends numerous branches, which anastomose with the supra-scapular, acromial, and anterior circumflex arteries.

*Varieties.* — In some cases, the posterior circumflex artery winds round the humerus in passing beneath the tendons of the teres major and latissimus dorsi, and not through the quadrangular space indicated above. In such case it usually gives off the superior profunda artery.

*The Anterior circumflex Artery* is a very small but a very constant branch. It passes horizontally forwards and outwards, covered by the coraco-brachialis muscle and short head of the biceps. It then crosses the bicipital groove, covered by its synovial membrane and by the long head of the biceps, and sinks beneath the deltoid muscle, in the substance of which it anastomoses with the posterior circumflex artery. The anterior circumflex artery supplies the coraco-brachialis biceps and subscapularis muscles. While crossing be-

hind the long head of the biceps it sends a delicate branch upwards, along the bicipital groove, to supply the head of the humerus and capsular ligament.

### *Operation of tying the Axillary Artery.*

This artery may be tied in its first and third stages, but cannot, with safety, in the second stage, in consequence of its being closely embraced on all sides by the termination of the brachial plexus.

*In the first stage*, the operation is extremely difficult, on account of the depth of the artery, and the difficulty of distinguishing it from the surrounding nerves of the brachial plexus, and the probable occurrence of troublesome venous hæmorrhage. For this reason the ligature of the subclavian, in its third stage, is generally preferred for the cure of axillary aneurism. The following mode of operating is essentially the same as that recommended by Mr. Hodgson. The patient is to be seated in a reclining chair, or laid on a table, so as to let the light fall on the site of the operation. The arm being abducted, a semilunar incision is to be next made, commencing within an inch of the sternal end of the clavicle, and stopping short, externally, at the edge of the deltoid muscle, to avoid injuring the cephalic vein. This incision will have its convexity turned downwards, and divide the integuments and platysma myoides. The fibres of the great pectoral muscle are then to be divided in the same manner, and to the same extent. On retracting the lips of the wound, the pectoralis minor muscle will be seen crossing it inferiorly. This muscle may now be re-

laxed, by bringing the arm nearer to the side, and depressed with a blunt instrument, so as to give more room. By cautiously scraping through the cellular membrane, the acromial artery will be found projecting over its edge, and will assist in guiding us to the axillary: the costo-coracoid ligament may be divided, if necessary, on a director. We should remember that the anterior thoracic nerve is in front of the artery; the brachial plexus above and without; and the vein (which often swells suddenly out during expiration) is anterior and internal to it. Having found the artery, the needle is to be passed round it, from within outwards, to avoid injuring the vein, which may, moreover, be drawn inwards with a blunt hook. Before tightening the ligature, we should ascertain that compression of the included part restrains the pulsation of the aneurismal tumour.

To this operation it has been objected, by the continental surgeons, that the pectoralis major muscle is divided transversely to a considerable extent, and the shoulder thereby considerably weakened. They, therefore, prefer an incision in the course of its fibres, and separating its clavicular from its sternal origin.

*In the third stage,* the axillary artery may be reached either by cutting through the anterior wall of the axilla, or through its base. If we prefer the former plan, we make our incision about three inches long, over the cellular interval between the deltoid and great pectoral muscles, taking care not to injure the cephalic vein. After scraping through some cellular

tissue the pectoralis minor muscle* is exposed; and beneath it (*i. e.* nearer to the base of the axilla) we can feel the common cord formed by the vessels and nerves. The distended vein is then drawn inwards, and the artery which lies between the roots of the median nerve is to be insulated carefully, and tied.

The operation through the base of the axilla may be thus performed:—The patient being placed on a table, and the arm abducted and supinated, an incision about two inches and a half in length should be cautiously made through the integuments and fascia of the axilla in the direction of the head of the humerus. By carefully scraping through cellular tissue the axillary vein will be exposed. The median nerve will also present itself, and may be drawn outwards while the vein is pressed inwards and the aneurism needle carried cautiously round the artery from within outwards.

As the student will find it expedient to examine hereafter the superficial veins on the front of the elbow joint, he will find it advisable now to make an incision along the internal margin of the arm and forearm so as to divide the fascia in this situation, which, along with the veins, may be reflected outwards till the brachial artery and its branches have been examined.

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* Delpech divides the pectoralis minor. He has twice taken up the artery successfully for hæmorrhage after amputation.—*Clinique Chirurg.*

## THE BRACHIAL ARTERY.

The *Brachial Artery* is a continuation of the axillary. It commences opposite the lower margin of the teres major and latissimus dorsi tendons, passes obliquely downwards and outwards, and terminates nearly opposite the coronoid process of the ulna. *Posteriorly* it corresponds,—first, to the triceps muscle, from which it is separated by the superior profunda artery and musculo-spiral nerve; next, it rests on the insertion of the coraco-brachialis muscle; and, in the remainder of its course, it lies on the brachialis anticus. In *front* it is first covered by the fleshy belly of the coraco-brachialis muscle, then by the biceps muscle, and, still lower, by the semilunar fascia, sent off from the biceps tendon. *Internally* it is related to fascia, integuments, and basilic vein; and *externally* to the coraco-brachialis muscle and cellular interval between the biceps and brachialis anticus.

The brachial *nerves* surround it, having the following relations:—Behind it, for a short distance, is the musculo-spiral nerve. The external cutaneous at first descends along its outer edge, separating it from the coraco-brachialis muscle, but lower down, towards the middle of the humerus, it inclines outwards, and loses its relation to the artery. The internal cutaneous lies at first on its inside, being situate on the front of the ulnar nerve, which it consequently separates from the median. Lower down the branches of the internal cutaneous become superficial, and one principal filament covers the artery at its termination. The

ulnar nerve descends on the inside of the vessel, but towards the middle of the humerus separates from it, and inclines inwards, to accompany its inferior profunda branch; and, lastly, the median nerve lies on the outside of the brachial artery above, but lower down crosses it (usually in front) to get to its inside. The *veins* that accompany it are two in number, and termed venæ comites: about the middle of the arm they open into the basilic vein. Such are the relations of the brachial artery in its course down the arm. At its termination it sinks into a triangular space, bounded on the outside by the supinator longus, and on the inside by the pronator radii teres. In this space it lies on the brachialis anticus muscle, having the tendon of the biceps to its outside, and the median nerve (as already explained) to its inside, while in front it is covered by an aponeurotic slip of a semilunar form, sent downwards and inwards from the tendon of the biceps muscle to join the anti-brachial fascia a little below the internal condyle.

*Anomalies.* — The most common irregularity of the brachial artery is a high bifurcation into the radial and ulnar. This may occur in any part of its course. In this case the radial and ulnar arteries, having arrived in the fore-arm, may pursue their usual course, or the radial may in rare cases run superficially, or the ulnar may be the superficial branch. Mr. Burns observes, that, when the ulnar is the anomalous branch, the bifurcation usually takes place higher up than when the radial is irregular.

In the high bifurcation, the radial artery usually lies at first on the inside, and afterwards crosses the ulnar, or continued trunk, to become external. These two vessels may be connected in their course by a transverse branch; and the transverse branch may give off *a median artery*, which descends on the front of the forearm

in company with the median vein. In other cases the median artery may come from the brachial, radial, or ulnar. It usually terminates in the superficial palmar arch, sometimes in the deep one.

There is, I believe, no case on record in which the brachial artery bifurcated below the coronoid process. Dr. Quain mentions, in the last edition (for 1838) of his Elements of Anatomy, a remarkable instance, in which the brachial artery divided into two branches, and, lower down, reunited to form a single trunk, which afterwards bifurcated regularly into the radial and ulnar.* I shall have occasion hereafter to notice two instances of a similar disposition of the femoral artery. In three cases out of forty, Mr. Harrison found a small branch arising from the upper part of the brachial and descending to the elbow, where it joined the radial artery. In two instances this superficial branch descended in the fore-arm beneath the superficial flexors, and was distributed to the muscles in this region; and in two other cases it accompanied the brachial nerve beneath the annular ligament of the carpus, and joined the superficial palmar arch of arteries. These have been described under the name of vasa aberrentia (*Burns*); they are frequently of considerable size.

The next variety to be noticed is the brachial artery, giving off the interosseous. A case of this kind came under my own observation in the Richmond hospital school. In some rare cases the

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* Since writing the above, Mr. Norton, of the Royal Liverpool Institution, has informed me that he met a similar case. Dr. Geddings, of Maryland, in speaking of the varieties of the brachial artery, observes, "In some instances the radial and ulnar arteries, after separating high in the arm, or axilla, pass for a limited distance down the arm, and then unite." He gives no reference however, but may possibly allude to the following passage in the work of Dr. Green, who is quite explicit on the subject:—"Sometimes the axillary artery divides into two vessels, which again unite at the fold of the arm, so that there are in reality two brachial arteries lying close to one another, and of equal magnitude. I have seen two striking examples of this kind. In one case, the brachial divided into two branches, which in like manner conjoined above the fold of the arm."

brachial artery divides at one point into three branches: viz., the radial, ulnar, and interosseous.

We may now replace the fascia and veins of the elbow and fore-arm, and examine them more particularly. Venesection is usually performed at the bend of the elbow, because there are, in this situation, a number of superficial veins, easily made prominent, and easily compressed. The accompanying figure represents the usual appearance of these veins on the front of the fore-arm. On the outside we observe *the cephalic vein* ascending, deriving its principal origin from the cephalic vein of the thumb.—On the inside we see *the basilic vein*, which seems to be a continuation of the small vein of the little finger, termed *salvatella*.—On the middle line of the front of the forearm we see *the median vein*, which, as it approaches the elbow-joint, divides into an internal and external branch: the internal branch is *the median basilic vein*; it crosses the front of the brachial artery at a very acute angle, being separated from it immediately beneath the bend of the elbow by the semilunar process of the biceps tendon. Some of the branches of the internal cutaneous nerve pass in front of it, and others behind it. The external branch, smaller than the internal, is termed *the median-cephalic*. It ascends obliquely upwards and outwards in front of the trunk of the external cutaneous nerve to join the cephalic vein. The basilic and cephalic veins being thus reinforced, ascend in the arm, the former along the internal and the latter along the external margin of the biceps muscle. The basilic vein receives the venæ comites of the brachial artery, and its continuation becomes the axillary vein.

When we proceed to perform venesection, we find that the median basilic is the vein which presents itself most prominently. If this be selected for the operation, great caution will be necessary, in order to avoid wounding the artery that lies beneath it. On this account, the student should avoid this vessel till he has become somewhat expert. A wound of the artery during venesection may be denoted by the blood issuing in jerks and of a bright arterial colour. These appearances may exist, however, without any such wound, and therefore need not excite alarm; and on the contrary, the artery may be punctured without any particular symptom to indicate the accident. When there is reason, *from*

*the great force with which the blood is projected,* to suspect that this accident has occurred, and there is no pain, swelling, or effusion present, we may apply a graduated compress, keep the limb quiet, and wait the results, which may be various. Sometimes the wounded vessel may heal without any unpleasant consequence; in others the external wound of the vein is healed, but there remains a communication between the artery and vein. If the communication between the two vessels is direct, that is, without any intermediate sac or canal, the affection is termed *aneurismal varix;* but if the cellular tissue has been distended into the form

of a canal of communication between the two vessels, the disease is then termed *varicose aneurism*. The latter is the more serious, as it may terminate in aneurism of the artery; but it is seldom that either of them require any operation. Matters do not, however, always go on as favourably as here represented. We may find, on removing the bandage, that the wound is disunited and filled with a coagulum, at the side of which florid blood is occasionally escaping. If the examination has been deferred too long, the extravasated blood is found extensively diffused throughout the limb. Scarpa observes, that in these cases the effusion will have a conical form; its apex being turned to the axilla and its base to the wound. Under these circumstances it becomes necessary to tie the brachial artery. Mr. Harrison thinks it is sufficient to tie this vessel above the wound, and quotes Mr. Colles's opinion in favour of this practice. Subsequent experience, however, has proved the danger of trusting to a single ligature. The anastomoses are so free about the elbow-joint, that fresh blood, as Mr. Porter observes, "is carried round by the collateral circulation, and as it constantly oozes from the punctured artery, it disturbs the coagulum in the neighbourhood, and bursts out into new and repeated hæmorrhages, until the surgeon is obliged to end where he ought to have begun, by cutting down (if he has still the opportunity) directly on the injured part of the vessel, and tying it above and below the aperture." — Article *Artery*, Todd's Cyclopædia. A little farther on, Mr. Porter observes:—"The only case in which such practice could succeed is, where, after the ligature had been tied, a sufficient degree of pressure *ab externo* could be maintained to lay the opposite sides of the wounded artery together, and produce sufficient inflammation to procure its complete obliteration; in short, that it shall effect that which the resistance of the skin and fascia and other superincumbent structures would have accomplished in a limb less injured. Such pressure as this must occasion intolerable suffering, and experience has proved in numerous instances how little reliance can be placed on it."

Of the many instances that might be adduced to prove the danger of trusting to a single ligature, I shall only notice the following, which has been related by Mr. Guthrie: — A man of a good constitution received a wound of the brachial artery at the bend of the arm. The artery was tied above the wound. Secondary hæmorrhage set in. It was then tied higher up. A third

operation was necessary. At length the limb was amputated, and the patient died.

*Ligature of the Brachial Artery in the superior Third of the Arm.* — The arm being abducted and rotated outwards for the purpose of diminishing the depth of the wound, an incision, about two inches and a half long, may be made over the ulnar margin of the coraco-brachialis muscle, the belly of which may be felt through the integuments. This should be done with much caution, as the integuments are thin in this situation, and the basilic vein and internal cutaneous nerve lie immediately under the knife. The fascia being next divided on a director to the same extent, the cellular tissue may be scraped through with the handle of a knife, till the artery and nerves are brought into view. The basilic vein, together with the internal cutaneous and ulnar nerves, may be drawn to the inside, and the median nerve to the outside, and the needle passed from within outwards. The separation of the artery and nerves will be facilitated by flexing the limb.

The operator will bear in mind the possibility of a high bifurcation, and of the superior profunda artery arising from the posterior circumflex and assuming the position of the brachial artery.

*Ligature of the Brachial Artery in the Middle of the Arm.*—The elbow-joint being extended and the arm rotated outwards, an incision should be made, about two inches and a half long, on the internal margin of the biceps muscle. Having divided the integuments and drawn the basilic vein out of the way, the fascia

will next be divided on a director. In some cases the vein lies beneath the fascia. By drawing outwards the biceps muscle with a blunt retractor, the artery may be exposed with a small vein on either side, and the median nerve usually in front of it. The nerve is to be drawn to the inside, and the needle passed from within outwards. The operator should remember that internal and posterior to the brachial artery, in this situation, descends the inferior profunda artery in company with the ulnar nerve. To avoid tying the latter artery in mistake, he should first take care to direct the edge of his knife, not backwards, but towards the centre or axis of the humerus, and afterwards satisfy himself that the compression of the vessel stops the pulsation in the aneurismal tumour.

Should there be two vessels, and that the compression of both is found necessary to cause the pulsation of the sac to cease, they should be *both* tied.

If the operation be performed in the *inferior third of the arm*, the internal edge of the biceps will be our guide here also; the median nerve will be on the inside of the artery, and the internal cutaneous nerve and basilic vein will be encountered in coming down on it.

*Ligature of the Brachial Artery at the bend of the Elbow.* — The elbow-joint being extended, the hand supinated, an incision may be made, commencing at the internal margin of the median basilic vein, about an inch above the internal condyle, and carried downwards and a little outwards for about two inches and a half, along the radial margin of the pronator radii teres. The vein and external lip of the wound being

drawn outwards, the fascia and semilunar process of the biceps tendon may be successively divided on a director. At the bottom of the wound will be found the biceps tendon externally, the median nerve internally, and the artery between and a little behind them. The needle may then be passed behind the artery from within outwards. Several small branches of the internal cutaneous nerve are necessarily divided in this operation. The superficial veins should be carefully kept out of the way; if one of them, however, should unavoidably interfere with the operation, Velpeau advises "to cut it between two ligatures, or even without this precaution, if not very large."

If the operation be performed for a wound in the artery with extravasated blood, we should cut through the sac and discharge the blood; then having exposed the artery, introduce a probe within its aperture, and having raised it and separated it from the median nerve pass a double ligature beneath it. The double ligature may be afterwards divided into two separate ones, and the artery secured above and below the wound. This is the treatment that Scarpa recommends for diffuse aneurism following puncture of the brachial artery; but we have already seen that it is equally necessary in circumscribed aneurism. During the operation, the brachial artery should be compressed either by an assistant or with the tourniquet. If the aneurismal tumour be very prominent, the veins in front will be obliterated. (See *Liston's Practical Surgery.*)

The principal branches of the brachial artery are three in number; viz. the superior profunda, inferior profunda, and anastomotic.

The *Superior Profunda* arises a little beneath the conjoined tendon of the teres major and latissimus dorsi muscles, and then sinks, in company with the musculo-spiral nerve, into a canal formed by the three heads of the triceps muscle and the bone. From the back of the humerus it winds round to its outside in a spiral groove, which may be observed in that bone beneath the insertion of the deltoid muscle. Here it divides into two branches, an anterior and posterior. The *anterior* pierces the external intermuscular ligament, and, accompanied by the musculo-spiral nerve, descends in a groove between the brachialis anticus and supinator longus muscles, to anastomose with the anterior radial recurrent artery. In this groove it is covered by the cephalic vein and by the external cutaneous and musculo-spiral nerves. The *posterior* branch descends in the substance of the triceps muscle, to which it sends numerous offsets, and terminates in anastomosing with the anterior branch and with the posterior radial and ulnar recurrents. The superior profunda artery is often very large, particularly when it arises from posterior circumflex.

The *Inferior Profunda Artery* arises nearly opposite the insertion of the coraco-brachialis muscle, and descends on the outside of the ulnar nerve, pierces with it the internal intermuscular ligament, and descends between this ligament and the triceps muscle to the interval between the internal condyle of the hume-

rus and the olecranon process of the ulna, where it is covered by the ulnar nerve, and anastomoses with the posterior ulnar recurrent artery. In this course it supplies the integuments of the arm and the biceps and triceps muscles. This artery may be small, absent, or double, or may arise in common with the superior profunda.

The *Anastomotic Artery* arises from the inside of the brachial, a little above the bend of the elbow, then descends obliquely inwards, pierces the internal intermuscular ligament, and terminates, between the internal condyle and olecranon process, in anastomosing with the inferior profunda artery and posterior ulnar recurrent. The anastomotic artery varies considerably in size, being usually small, but sometimes as large as the inferior profunda.

The other branches of the brachial artery are the muscular branches and the nutritious artery.

The *Muscular Branches* are distributed in all directions: some go forwards to the biceps muscle, others backwards to the brachialis anticus; a third set are distributed externally to the coraco-brachialis muscle, and a fourth internally extend to the pectoral muscles.

The *Nutritious Artery* arises high up from the brachial, and penetrates obliquely the foramen that may be observed on the inside of the humerus. It supplies the medullary membrane and cancellated structure of the bone, and anastomoses with its other nutritious arteries, which are much smaller, and enter at various points, particularly near the extremities. Mr. Harrison relates a case in which an aneurism of this artery

ensued on a fracture of the humerus, and amputation was deemed necessary. — (*On the Arteries*, p. 185.)

At the bend of the elbow the brachial artery divides into the ulnar and radial arteries.

### *The Ulnar Artery.*

The *Ulnar Artery*, larger than the radial, proceeds at first obliquely downwards and inwards beneath the pronator radii teres muscle (the deep head of which separates it from the median nerve), then beneath the flexor carpi radialis, palmaris longus, and flexor sublimis digitorum. In this course it lies on the flexor profundus, and is usually accompanied by a filament of communication between the median and ulnar nerves. In the remainder of its course to the annular ligament it descends vertically on the flexor profundus muscle, covered by the flexor carpi ulnaris and flexor sublimis, and may be seen by dividing the fascia and separating these two last mentioned muscles. It is joined by the ulnar nerve at the junction of the superior and middle thirds of the fore-arm, after which it has this nerve to its ulnar side as far down as the wrist joint. It gets into the hand by descending in front of the annular ligament, covered, however, by an aponeurotic slip, connecting the front of that ligament to the pisiform bone. In this situation the nerve lies a little posterior to its artery.

The following are the principal branches of the ulnar artery:—

1st. An *Anterior Ulnar Recurrent*, which is small, and sometimes derived from the posterior ulnar recurrent. This first passes obliquely downwards and inwards,

between the pronator teres and brachialis anticus, and then, curving upwards, gains the front of the internal condyle, and anastomoses with the anastomotic branch of the brachial artery. In this course it supplies the brachialis anticus, pronator teres, flexor carpi radialis, and flexor sublimis muscles.

2d. The *Posterior Ulnar Recurrent*, much larger, descends at first a little inwards, between the deep flexor digitorum, which lies behind it, and the muscles arising from the internal condyle, which lie in front. It then ascends parallel to the ulnar nerve, and between the heads of the flexor ulnaris, to gain the interval between the internal condyle and olecranon process. Here it terminates in communicating with the anastomotic and inferior profunda branches of the brachial; having previously supplied the above mentioned muscles, as also the elbow-joint, ulnar nerve, and integuments.

3d. The *Common Interosseous Artery* comes off immediately beneath the recurrents, and descends backwards and outwards to the superior margin of the interosseous ligament, where it divides into the anterior and posterior interosseous. Before its division it gives off a small artery that accompanies the median nerve to the wrist, where it terminates; occasionally it is of considerable size, and joins the superficial palmar arch. *The Anterior Interosseous Artery* descends on the front of the interosseous ligament, between the flexor pollicis longus and flexor profundus muscles, being covered in front by a branch of the median nerve. Having arrived at the pronator quadratus muscle, it divides into two branches: one supplies this

muscle, and terminates in anastomosing with the carpal arteries and the deep arch; the other passes backwards, through an oval opening in the interosseous ligament, to anastomose with the posterior carpal and posterior interosseous arteries. The *Posterior Interosseous Artery* proceeds downwards and backwards, passes between the anterior oblique and interosseous ligaments, and, having thus arrived at the posterior superior part of the fore-arm, gives off the *Posterior Radial Recurrent Artery*, which ascends between the supinator brevis and anconeus muscles, and then through the fossa between the external condyle of the humerus and the olecranon process: after piercing the triceps muscle it terminates in anastomosing with the superior profunda and posterior ulnar recurrent arteries. After giving off this branch the posterior interosseous descends on the back of the fore-arm, not lying on the interrosseous ligament, but between the superficial and deep layer of muscles. In this course it is accompanied by a filament of the musculo-spiral nerve, and gives off numerous branches to the surrounding muscles: at the wrist it is very small, and terminates in anastomosing with the anterior interosseous and posterior carpal arteries.

The *Posterior Carpal Branch* of the ulnar comes off about an inch and a half above the pisiform bone: it winds round the inferior extremity of the ulna to the back of the carpus, in passing beneath the tendon of the flexor ulnaris muscle. It terminates by anastomosing with the posterior carpal branch of the radial.

The *Anterior Carpal Branch*, extremely small, passes horizontally outwards, along the inferior margin of the pronator quadratus muscle, and behind the tendons of the superficial and deep flexors. It anastomoses with the anterior carpal branch of the radial artery.

After the ulnar artery has arrived in the palm of the hand, it terminates by dividing into the communicans profunda and palmaris superficialis.

The *Communicans Profunda* should not be dissected till the palmaris superficialis and superficial arch of arteries have been examined (which see, in two next paragraphs). It passes obliquely downwards and inwards, between the pisiform bone and unciform process, then turns outwards, beneath the two muscles arising from the unciform process, viz., the short flexor and opponens minimi digiti, to join the palmaris profunda (a branch of the radial), and form the deep palmar arch. In this course it is accompanied by a large branch of the ulnar nerve, which lies superficial to it.

The *Palmaris Superficialis* is usually much larger than the preceding. It winds downwards and outwards, beneath the palmar aponeurosis, to inosculate with the superficialis volæ (p. 133.), and thus form

*The Superficial Palmar Arch of Arteries.*

This arch nearly corresponds to the semicircular fold on the palm of the hand that circumscribes the muscles of the thumb: it is, in general, smaller than the deep one, and its convexity, which looks downwards and inwards, is nearer to the phalanges. *Ante-*

*riorly* it is covered by the integuments and palmar aponeurosis. *Posteriorly* it lies on the flexor tendons, and the divisions of the median nerve as they pass to the fingers. In the fore-arm we see the radial and ulnar arteries lying between their corresponding nerves; but in the hand the order is reversed, the nerves being situated between the arches of arteries.

The *Branches of the Superficial Palmar Arch* arise either from its concavity or from its convexity. *Those from its concavity* are small and numerous: they supply the tendons of the flexor muscles, the lumbricales, and the annular ligament, and anastomose with branches of the radial and ulnar arteries. *Those from its convexity are termed the digital arteries.* The first, or most internal of them, supplies the ulnar side of the little finger; the second advances to the cleft between the little and ring fingers; the third to the cleft between the middle and ring fingers; and the fourth to the cleft between the middle and index fingers: each of them then bifurcates to supply the opposed surfaces of the corresponding fingers. These digital arteries follow the anterior and lateral margins of the fingers, supplying the digital articulations and synovial sheaths, and forming a vascular plexus beneath the nail of each finger. Those of the same finger frequently communicate both in its anterior and posterior region, and opposite the ungual phalanx meet in the form of an arch, the concavity of which looks towards the hand, and from the convexity of which are sent off numerous minute vessels to supply the extremities

of the fingers. The digital nerves are superficial (that is anterior) to the arteries, which either pierce or cross them to obtain this position.

If the ulnar artery be wounded in its superior third, we may either cut down through the mass of muscle that covers it (avoiding the median nerve), as Mr. Guthrie advises, or tie the brachial artery in its inferior third: I should prefer the latter proceeding. If this part of the artery be affected with aneurism, tying the brachial is the only proper course. If it be necessary to tie the ulnar artery lower down, it will be readily found by cutting on the interval between the flexor sublimis digitorum and flexor carpi radialis. The fascia should be divided on a director, and the needle carried round the vessel from within outwards, taking care to avoid the nerve which lies to its ulnar side, and the venæ comites which lie one on either side.

Wounds of the palmar arch generally bleed profusely. If a spouting vessel present itself, it may be seised with the tenaculum, and secured in a ligature. This practice, however, is seldom available, as the blood generally flows from a number of orifices, which are by no means distinct. In such case the surgeon should close the wound, and employ a compress; or, if this should fail, he may introduce into it a piece of sponge, covered with a bit of gauze, to prevent the lymph effused from lodging in its cells, and then apply a compress as before: this, with the temporary application of the tourniquet to the brachial artery, will usually be sufficient even in severe cases. Sometimes, however, it may be necessary to tie one or both arteries of the fore-arm. If the wound be on the radial side, we tie the radial first, and if on the ulnar side, the ulnar artery. It may be recollected, that sometimes the artery accompanying the median nerve, or the anterior interosseous artery, are particularly large, and terminate in the super-

ficial or deep arch. Hence, even the ligature of both arteries of the fore-arm has failed to restrain the hæmorrhage, and amputation has become necessary.

### *The Radial Artery,*

Smaller than the ulnar (but more in the direction of the brachial artery), descends towards the wrist, being related *posteriorly*, from above downwards, to the tendon of the biceps, the insertion of the supinator brevis, the pronator teres, radial origin of the flexor sublimis, flexor pollicis longus, and pronator quadratus muscles, *externally* to the supinator longus muscle, which overlaps it a little, and *internally* to the pronator teres above, and flexor carpi radialis lower down. *Anteriorly* it is covered only by fascia, integuments, and the approximation of the muscles at either side. In this course it is accompanied by two veins (the *Venæ Comites*), and in the two superior thirds of the fore-arm by the radial branch of the musculo-spiral nerve, which lies to its outer or radial side. At the lower extremity of the fore-arm this artery turns round the external lateral ligament of the wrist joint, being parallel to the radial extensor muscles, and covered by the extensor muscles of the thumb. Here it pierces the abductor indicis manus muscle, and terminates in crossing the palm of the hand under the name of the palmaris profunda.

The branches of the radial are,

1. The *Radial Recurrent.* — This branch, which arises high up in the fore-arm, proceeds at first transversely outwards, and then ascends on the front of the supinator brevis, in the groove between the supinator

longus and brachialis anticus, where it anastomoses with the superior profunda artery: from the convexity of its arch it sends many branches downwards to be lost in the supinator brevis and longus muscles, and in the upper extremities of the extensor muscles.

In its course down the fore-arm, the radial artery sends branches to the adjacent muscles, and through the aponeurosis to the integuments.

2. The *Superficialis Volæ*.—This is usually a small branch: sometimes, however, it is very considerable. It descends on the front of the annular ligament of the wrist, then over or through the origins of the small muscles belonging to the thumb. It next turns inwards, beneath the palmar aponeurosis, and, by anastomosing with the superficial branch of the ulnar artery, contributes to the formation of the superficial palmar arch already described (p. 129.).

3. The *Anterior Carpal Artery* is small but constant. It runs transversely inwards, along the inferior margin of the pronator quadratus, to anastomose with a similar branch from the ulnar.

4. The *Posterior Carpal Artery* is very much larger than the anterior. Its origin corresponds to the outer edge of the extensor radialis longior muscle, and is nearly opposite the interval between the first and second range of carpal bones. It passes almost horizontally inwards (lying on the second row of carpal bones, covered by the radial extensors and the extensors of the fingers) to anastomose with the posterior carpal branch of the ulnar artery. Its superior branches are distributed to the wrist-joint, and com-

municate with the anterior interosseous. Its inferior branches are *the second, third, and fourth perforating arteries*, each of which sinks between the heads of the corresponding dorsal interosseous muscle, to join the deep palmar arch. (See page 136.) The student may perceive that the trunk of the radial artery may be considered as *the first perforating artery*, as it pierces the first interosseous muscle, or abductor indicis manus, in a similar manner. Before these arteries pierce the muscles, they send off interosseous branches, that descend between the interosseous muscles and integuments, and occasionally pierce the lower part of the interosseous space, to join the digital branches of the palmar arch.

Before the radial artery sinks between the two first metacarpal bones it gives branches to the posterior and external region of the thumb, and often a slender branch that descends on the cutaneous surface of the abductor indicis manus.

5. *The Metacarpal Artery*, or dorsalis indicis, is very variable in size, being sometimes diminutive, and at other times extremely large. Cruveilhier met a case in which it formed the superficial arch. It descends over the metacarpal bone of the index finger, and sinks between the second and third metacarpal bones, to join the digital branch of the superficial arch that supplies the adjacent sides of the index and middle fingers.

6. The *Radialis Indicis* descends between the abductor indicis and adductor pollicis. It then follows the external margin of the index finger, and, at its extremity, anastomoses with the internal digital branch.

7. The *Princeps Pollicis*, or digital artery of the thumb, descends between the abductor indicis and deep head of the short flexor pollicis. It then follows the internal margin of the thumb, and anastomoses with the other digital vessels.*

8. The *Palmaris Profunda* passes horizontally inwards, between the metacarpal bones and interosseous muscles which are behind it, and the adductor pollicis and flexor tendons which lie in front. It then unites with the deep terminating branch of the ulnar, and thus constitutes

*The deep Palmar Arch of Arteries.*

This arch is covered in front by all the nerves, tendons, and muscles of the palm of the hand, except the interosseous muscles, which, together with the metacarpal bones, lie behind it. It crosses these bones nearly at right angles, lying immediately below their carpal extremities, and forming a slight curvature, the convexity of which looks towards the phalanges. The arch is accompanied by a branch of the ulnar nerve, which lies on its anterior surface, and terminates in the muscles of the thumb. The *superior*

* In some cases the radialis indicis and princeps pollicis arise by a common trunk, which descends to the lower part of the first interosseous space before it bifurcates: this is described as the regular disposition by Cloquet and Boyer. In other cases, as described by Mr. Harrison, the radial artery terminates by dividing into three branches: the radialis indicis, princeps pollicis, and palmaris profunda. Boyer specially mentions this arrangement as a variety. I have described the disposition which I have found most frequent and most simple.

*branches* of the deep arch are small, and lost on the carpus. The *anterior branches* are also small, and lost on the lumbricales muscles. The *inferior branches*, three or four in number, descend along the interosseous spaces, and anastomose with the digital branches of the superficial arch. Lastly, the *posterior branches*, three in number, pass backwards towards the second, third, and fourth interosseous spaces, to be continuous with the perforating branches (p. 134.) of the posterior carpal artery. Each of them penetrates between the two origins of the corresponding dorsal interosseous muscle to communicate with the posterior carpal artery, and may therefore be indifferently considered as branches of the last-mentioned artery (as described at page 134.), or of the deep arch. The superficial palmar arch has been described at page 129.

*Operation.*—The radial artery may be tied in the upper part of the fore-arm by making an incision over the interval between the pronator radii teres and supinator longus. In the lower part of the fore-arm it will be found between the flexor carpi radialis and supinator longus. In either case, after making the incision through the integuments, the fascia should be divided on a director. A small vein will be found on either side of it, and the radial nerve will lie on the external side. The possibility of mistaking the superficialis volæ for the trunk of the radial should be borne in mind. In judging of the strength of the pulse at the wrist it will be necessary to attend to the deviations in the course and size of the radial. Some of the most remarkable of these I shall now describe.

*Varieties of the Radial and Ulnar Arteries.* — A remarkable variety has been already noticed; viz., an origin of either vessel in the arm or axilla. Sometimes the ulnar artery arises regularly at the bend of the elbow, yet afterwards descends on the cutaneous surface of the muscles arising from the internal condyle, and accompanies the basilic vein. The radial artery may also, though regular in its origin, run superficial to the fascia. Dr. Barclay describes a case in which *both radial and ulnar* were superficial. Dr. Green saw a case in which a transverse branch joined the radial and ulnar at the lower third of the fore-arm. Sometimes the radial artery gives off the superficialis volæ high up in the fore-arm; this is more likely to occur in case of a high bifurcation of the brachial. If the superficialis volæ arise high up, the continued trunk of the radial may either descend along with it and on a deeper plane, or may turn round the radius near the lower third of the fore-arm, and descend in this region to the hand. Dr. Green saw two cases of this.

In addition to the above, we may quote the following remarkable variety, lately observed by Mr. Bennett Lucas, at the North London School of Medicine:—

"A female, aged seventy, exhibited in the distribution of her arteries the most uniform irregularity. Those of the upper extremities I have alone preserved, as they are highly interesting in a practical point of view. The brachial artery of the right side bifurcated as usual at the bend of the elbow into radial and ulnar arteries; but the radial was infinitely the larger. The ulnar artery, after running its usual course for about two inches, suddenly sent off a lash of branches; viz., a large recurrent, several fair-sized muscular, a huge interosseal, which ran down to terminate in the deep palmar arch, and a middle-sized 'continued trunk,' which lost itself in the superficial palmar arch, as it scarcely could be said to assist in its formation. The great radial trunk went its way, detaching few and insignificant twigs, and a quarter of an inch above the wrist-joint sent off a superficialis volæ, more as a matter of form than any thing else, for it soon expended itself in the muscles of the thumb. The undiminished trunk of the radial now turned round the outer edge of the carpus, and, at the angle formed by the metacarpal bones of the thumb and index finger, sent off two branches, the larger of which (the

other being spent in the adductor pollicis and abductor indicis muscles,) coursed along the inner edge of the metacarpal bone of the thumb, furnishing princeps pollicis, radialis indicis, and a retrograde branch, to form, with the nearly exhausted ulnar artery, the superficial palmar arch. From this arch proceeded four branches, the smaller of which went to the inner edge of the little finger, the next bifurcated to supply the opposed sides of the little and ring fingers, the third bifurcated to supply the opposed sides of the ring and middle fingers, but the fourth, a pitiable vessel, ran to the head of the third metacarpal bone, and there joined a large digital trunk derived from the deep palmar arch. The continued trunk of this radial artery, at length sensibly diminished, took its usual course to form the deep palmar arch. At the proximal end of the metacarpal bone of the index finger, the large digital artery, already alluded to, (merely acknowledging the receipt of the fourth superficial palmar artery) bifurcated to supply the opposed sides of the middle and index fingers. After forming the deep palmar arch, which sent off the usual arteries to the smaller palmar muscles, the radial trunk ran under cover of the muscular mass of the little finger, sending numerous branches therein, and then playfully turned upwards under the annular ligament, and united with the large interosseal artery from the ulnar.

"In this very uncommon, if not unique, distribution of arteries, we find the radial (a huge trunk) taking its usual course, and supplying the palm of the hand and all the fingers. Intent upon this purpose, it sends off but few, and these small, muscular branches, and a superficialis volæ of no account; and, merely condescending to make an intimacy with the ulnar and interosseal arteries, it takes upon itself, not alone to form the superficial palmar arch, but to form it much less in extent than the deep palmar arch — the arch which it forms in the natural distribution, and which is in such case much the smaller.

"On the left side of this subject the brachial artery divided as usual; but here the ulnar artery was very large and the radial artery very small. The radial, *immediately after its origin*, sent off the superficialis volæ, which vessel, though nearly the length of the fore-arm, was very delicate, and after detaching several small muscular branches, lost itself in the muscles of the thumb, without participating in the formation of the palmar arch. In its

course, it occupied the position of the radial artery. The radial trunk itself ran very superficially, and, at the junction of the middle and inferior thirds of the fore-arm, turned round the edge of the radius to the space between the metacarpal bones of the thumb and index finger, where it sent off the palmaris profunda to form the deep palmar arch in the usual manner, the radialis indicis and the princeps pollicis, and, in addition, a second palmaris profunda, which formed, by joining the trunk of the ulnar artery, a second deep palmar arch.

"The large ulnar sent off its recurrent branches, a posterior interosseal artery, two anterior interosseal arteries, and a long muscular artery. At the wrist it sent off its usual communicating artery, and in the palm of the hand, having received the second deep palmar branch of the radial, it supplied, as usual, three fingers and a half, without, however, forming any superficial palmar arch.

"The practical inferences to be deduced from these unusual distributions are plain, and of some importance. Had this individual been the subject of illness during her life, a very erroneous estimate of its intensity must have been indicated by the pulse; and did the practitioner depend chiefly on its condition, his practice would have been guided by the wrist he felt it at. Here, if the right pulse be felt, from the size of the radial, depletory measures would in all likelihood have been pursued; and were it the left, an opposite mode of treatment may have been adopted; and if both wrists were examined, they would, at the least, have given cause for deliberation in the case.

"In addition to the varieties of arteries always being, when they exist, a source of difficulty when a vessel is required to be secured, this individual, did she require to have her left fore-arm amputated, would have presented to the surgeon no less than seven considerable arteries for the ligature."

## THE DESCENDING AORTA

Commences opposite the lower part of the third dorsal vertebra, and terminates opposite the fourth lumbar. Its commencement and termination are both on the left side of the spine, but that part of it which passes between the crura of the diaphragm approaches the middle line, so that in its entire course it forms a lateral curvature, the convexity of which is turned to the right side. Besides this, it follows the curvatures of the spine, and is therefore concave forwards in the thoracic region, and convex forwards in the abdominal. Let us examine, first, its thoracic, and then its abdominal portion.

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### THE THORACIC AORTA

May be said to commence opposite the third vertebra and terminate in passing between the pillars of the diaphragm. Its direction is downwards, forwards, and to the right side. Its *posterior surface* rests on the spine and demi-azygos vein, and gives off the intercostal arteries. Its *anterior surface* is covered by the root of the left lung, by the back of the pericardium and left auricle, and lower down by the œsophagus and the muscular bands that connect the pillars of the diaphragm. Its *left side* is related to the pleura; the *right side* is in contact with the œsophagus, superiorly; but lower down it corresponds to the right

pillar of the diaphragm, from which it is separated by the vena azygos and thoracic duct. The right and left splanchnic nerves descend on either side of it, the left being the nearer. Its branches are — the bronchial and œsophageal, which arise from its anterior surface; and the inferior intercostals, which arise from its posterior surface.

### *The Bronchial Arteries*

Are among the most irregular in the body: they can only be recognised by their termination in the lung, and not by their origin; as they may arise from the aorta, the intercostals, the mammary, or even from the subclavian arteries. Those most constantly found, are three in number; viz., one on the right side, and two on the left. 1. The *right bronchial artery* sometimes comes from the aorta, in common with the left, or separately. More usually, however, it is a branch of the first aortic intercostal. In all cases it descends on the back of the right bronchus, and, winding round it, accompanies it into the lung. 2. The *superior left bronchial* usually comes from the aorta, and, in a similar manner, twines round the left bronchus, and with it enters the lung. 3. The *inferior left bronchial artery* often arises from the aorta, opposite the third or fourth dorsal vertebra, and is conducted to the left lung by the left superior pulmonic vein: it is not as constant as the two preceding. Arrived at the lung, the right bronchial usually divides into five branches, and the left into four. They subdivide, and accompany the divisions of the bronchi through the lung, in such

manner, however, that one division of the bronchus has usually with it two or three arterial branches, which, frequently anastomosing, form a delicate network round the air-vessel. The bronchial arteries communicate with all the other blood vessels of the lung.

Two or three other bronchial arteries may arise occasionally from various points of the aorta, and also repair to the lung. Other varieties have been already noticed.

### *The Œsophageal Arteries,*

Three to six in number, arise from the anterior part of the thoracic aorta, at variable points. They are lost in the various tunics of the œsophagus, and in anastomosis with the œsophageal branches of the gastric artery. They are always very small, and the highest of them occasionally comes from one of the bronchial arteries.

### *The Inferior or Aortic Intercostals*

Are usually from nine to ten in number on each side, according as the superior intercostal gives off three or two branches. They all arise from the posterior and lateral part of the thoracic aorta. The superior run obliquely upwards and outwards, the middle less obliquely outwards, and the inferior almost transversely. *Those of the right side,* having to cross the spine, are necessarily longer than on the left side, and have additional relations. From their origins to the angles of the ribs, they

rest on the spine posteriorly, and are covered in front by the œsophagus, thoracic duct, vena azygos, sympathetic nerves, and the pleura. *Those of the left side*, traced as far as the heads of the ribs, rest on a very little of the spine, and are only covered by the sympathetic nerve and pleura.

In the remainder of their course, being exactly alike on right and left, the same description will serve for both sides. There are some differences, however, between the relations of those above and below. Thus the superior aortic intercostal communicates with the lowest intercostal branch from the subclavian, while each of the others communicates with the aortic intercostal above and below it. Lastly, those low down cross behind the splanchnic nerves on both sides, and behind the demi-azygos vein on the left side, and the eleventh and twelfth intercostal on either side pass behind the corresponding pillar of the diaphragm.

Having arrived in the intercostal space, each of these arteries divides into an anterior and posterior branch.

The *anterior branch*, larger than the posterior, proceeds outwards towards the angle of the rib, having in front of it the pleura, and behind it the anterior (or inferior) costo-transverse ligament and the external intercostal muscles. Arrived near the angle of the rib, it divides into a superior and inferior branch, both of which sink between the two layers of intercostal muscles. The inferior, much the smaller, runs for a short distance along the superior margin of the rib.

below, and is then lost in the periosteum, on its external surface; while the superior, which is really the continued anterior intercostal, runs forwards between the two layers of intercostal muscles, lodged in the groove in the inferior margin of the rib above, till it reaches the anterior part of the thorax; its corresponding vein lying above, and its nerve beneath it. Here it descends in the intercostal space, and its mode of termination depends on its situation: those corresponding to the true ribs anastomose with the internal mammary artery; those corresponding to the false ribs sink into the abdominal muscles, and, having supplied them, anastomose with the mammary, epigastric and circumflexa ilii arteries. The twelfth anterior intercostal differs somewhat from the preceding; it runs downwards and outwards, between the corresponding crus of the diaphragm and the body of the last dorsal vertebra; then along the inferior margin of the twelfth rib, opposite the middle of which it divides into transverse and descending branches: they are lost in the broad muscles of the abdomen, and in communication with the lumbar and circumflexa ilii vessels.

The *posterior branch* of each intercostal artery proceeds backwards, between the body of the corresponding vertebra on the inside and the inferior costo-transverse ligament on the outside. In this situation it sends a small branch through the lateral foramen of the spine to the tunics of the spinal marrow, and then continues its course backwards to be lost in the spino-transverse longissimus dorsi and sacro-lumbalis muscles.

Some of its branches extend to the latissimus dorsi and trapezius muscles, and are lost in the integuments.

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### The Abdominal Aorta

Cannot be examined till its branches have been dissected. It extends from the opening in the diaphragm to the left side of the fourth lumbar vertebra. It may, however, extend to the fifth, or only as far as the second. Its direction is downwards, and to the left side. Its *posterior surface* rests on the spine, right crus of the diaphragm, receptaculum chyli, sympathetic nerve, and left lumbar veins, and gives origin to the lumbar and middle sacral arteries. The *anterior surface* is covered from above downwards, first by the posterior edge of the liver, next by the semilunar ganglion and lesser omentum, then by the commencement of the vena portæ and superior mesenteric artery, both of which separate it from the pancreas; lower down, by the left renal vein, which separates it from the third portion of the duodenum; still lower, by the transverse mesocolon and mesentery, and inferiorly by a single layer of the peritoneum. Its *left side* corresponds to the left pillar of the diaphragm above, and below to the peritoneum. Its *right side* is separated from the cava, superiorly, by the Spigelian lobe of the liver, the right crus of the diaphragm, the vena azygos, and the thoracic duct; lower down it is nearly in contact with this vein.

The aorta sometimes bifurcates at the third lumbar vertebra, or even as high as the second*, or immediately after giving off

* Anatom. Societ. a. g. Mars, 1835.

renal arteries.* In a child born with imperforate anus, the aorta divided in the lumbar region into two branches; *one* of which gave off the inferior mesenteric, then crossed to the back of the bladder, and ascended along the median line to bifurcate at the umbilicus; *the other* branch, situated behind the former, was reflected toward the right sacro-iliac symphysis: having supplied the left side of the pelvis and left lower extremity, the continuation of it became the right femoral. Other anomalies observed in the same subject will be found in the note.†

*Operation of tying the Aorta.*

The abdominal aorta has been tied three times in the human subject, but unfortunately in every case without success. Sir A. Cooper was led, by a number of experiments‡ which he performed on dogs, and by a consideration of the various cases§ on

* Journal des Progrès, 1828, vol. viii. p. 191.

† In this child the arch of the aorta gave off three branches: 1st, a trunk common to both carotids; 2dly, a left subclavian; 3dly, a right subclavian, which crossed behind the œsophagus. The left kidney and renal artery were wanting. (*Dr. Green's Manuscript.*)

‡ See Medico Chirurg. Trans. vol. ii. p. 158. Sir A. Cooper says he has ascertained that if the aortic plexus be tied with the artery, the lower extremities are rendered paralytic and the animal dies; but these consequences do not occur if the plexus be not included in the ligature. (*Surgical Lectures.*)

§ A case of obliteration of the aorta immediately below its arch, was seen by Paris. It appeared, from examination of the body, that, during life, the blood which was expelled from the heart must have been transmitted into the trunk of the aorta below the constriction, by passing through the subclavian, axillary, and cervical arteries. From these latter it passed into the vessels of the thoracic and abdominal viscera, and those of the lower extremities. (*Dessault's Journal*, vol. ii.) Dr. Graham, of Glasgow, published another example of complete obstruction of the aorta just below the ductus arteriosus. (*Med. Chirurg. Trans.* vol. v. p. 287.) There are several other cases of this kind recorded. I shall have occasion hereafter to allude to one observed by *Rainy*.

record, in which the aorta had been found obliterated after death, to believe in the possibility of tying this vessel in the human subject with safety and advantage. It is true that in every instance in which it was found impervious in the human subject, the effect was produced slowly, and the anastomosing branches were gradually prepared for the additional duty they were to perform; yet it does not appear, either from experiments on brutes, from which, however, conclusions should be drawn with great caution *, nor from the results of the three cases in which it has been tied in man, that the operation is likely to fail, either on account the shock given to the system or of the diminished supply of blood sent to the lower extremities.

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The following instances, having occurred in the abdominal region, are more to our present purpose. *M. A. Severin* speaks of an obstruction of the aorta beneath the emulgent arteries. *Monro* describes an obliteration of this vessel above the common iliac arteries. *Crampton* also saw it obliterated in the abdominal region; and *Larrey* and *Key* have described similar cases. Lastly, Dr. *Goodison*, of Wicklow, examined at Paris the body of a woman in whom the aorta was obliterated immediately beneath the inferior mesenteric artery. The left common iliac artery was impervious in its entire length, and the right common iliac in one half. (*Dub. Hosp. Reports*, vol. ii. p. 193.) The history of the case could not be traced, but the limbs did not appear at all emaciated. Mr. Crampton, the surgeon-general, examined the preparation, and was of opinion that the obliteration was the effects of a process by which an aneurism had been spontaneously cured. In all of the above cases, the circulation had been established below the obstruction; and in none, except the cases of Rainy and Key, did there appear to have been any weakness in the limbs.

* One of the dogs experimented on by Scouttetten died of peritonitis seven days after the operation. This surgeon had previously obliterated in succession in the same dog the two femoral arteries, two subclavians, and two carotids. From all of these the wretched animal recovered; and we are told that even after the aorta was tied he had commenced walking, and ate with a good appetite! This strongly proves the caution necessary in reasoning from the results of experiments on brutes.

*Sir A. Cooper's Case.*—A patient in Guy's Hospital had violent bleeding just above the left groin, from an aneurismal tumour of the external iliac artery. The integuments had sloughed, and the patient was exceedingly reduced from loss of blood. Under these circumstances, and finding it impossible from the size of the tumour to secure the iliac artery, Sir A. Cooper naturally felt justified in tying the aorta.

*The operation* was performed in April, 1817. He made an incision into the linea alba three inches long, allowing a curve in it to avoid the umbilicus. In this manner the sac of the peritoneum was opened, and the fingers were then conveyed to the artery, which was readily distinguished by its strong pulsations. The peritoneum was then lacerated with the finger nail, in order to allow the ligature to be conveyed around it at about three quarters of an inch above its bifurcation. During the operation the fæces were involuntarily discharged. The patient died on the second day after the operation; and his death is ascribed by Sir A. Cooper to want of circulation in the aneurismal limb, which led him to observe that "in an aneurism similarly situated, the ligature must be applied before the swelling has acquired any very considerable magnitude." (*Surgical Essays*, vol. i. p. 114.) In his surgical lectures he observes, "If I were to perform this operation again, the only difference that I would make, would be to cut the ligature close to the vessel, where it would take its chance either to be encysted or absorbed." A little farther on he observes, "The principal danger appeared to arise from the irritation produced in the intestines by the ligature; and that is the reason why I would cut the ligature close to the vessel." In dissection there were no appearances of peritoneal inflammation.

*Mr. James's Case.*—"The patient, æt. 44, of spare habit, but not otherwise unhealthy, had an aneurism of the external iliac artery, of such extent as to prevent any chance of success from tying the iliac artery above the tumour. It was accordingly determined to tie the femoral artery on the distal side of the aneurism, according to Brasdor's plan. This operation was performed on June 2. 1829. The patient appeared to be going on well until the 12th, after which the tumour gradually increased; and on the 24th the integuments were tense and shining, and there was considerable pain." Mr. James accordingly felt it his

duty to give his patient the only remaining chance, by putting a ligature round the aorta. The operation was accordingly performed, on the 5th of July, in the manner practised by Sir A. Cooper. We shall find, farther on, that the aorta may in general be tied without wounding the peritoneum; but in this case it would have been impracticable, as the serous membrane adhered firmly to the anterior surface of the tumour. The patient died on the evening of the operation; and on opening the body a remarkable anomaly was observed: the external iliac artery divided, above Poupart's ligament, into two branches; one of which gave off the epigastric, and afterwards represented the profunda, while the other took the course of the femoral artery.

*Dr. Murray's Case.*—A Portuguese sailor applied at the Civil Hospital, at the Cape of Good Hope, with a large aneurismal tumour over the site of the external iliac artery.

"The tumour now presents the greatest size and prominence immediately above Poupart's ligament, in the site of the external iliac artery. The most prominent part is tense, shining, and circumscribed, about the size of an orange, and its hard irregular base extends upwards to an imaginary line drawn from the umbilicus to the lower ribs, and downwards to a couple of inches below Poupart's ligament; its lateral boundaries being formed by the ilium and linea alba. Pulsation is felt in the prominent part of the tumour, and a sort of whizzing sound is indistinctly discovered in it on the application of the ear or stethoscope; but there appears to be no circulation in the femoral artery. He does not complain of much pain in the tumour at present, but says it is often excruciatingly severe along the thigh bone, and in the knee. The limb is much swollen, and he keeps it constantly in the bent position, and cannot bear to have it extended. The skin is nearly insensible to the touch, and even to pinching, particularly on the inner part of the thigh; yet he describes having a feeling as if worms and flies were creeping over it. Temperature of the diseased limb 92 degrees, and of the sound one 97. Pulse 96, and intermittent; and the action of the heart has a corresponding irregularity. Two or three days ago he had an attack of epistaxis. Tongue covered; respiration natural; intellect clear. Has had scarcely any sleep for many nights, and no motion in his bowels for eleven days."

He was accordingly taken into the Hospital, and medicines

calculated to palliate his symptoms were employed. After a few days, however, matters were getting manifestly worse. His features were shrunk, and exsanguine, limb cold and insensible, and the tumour enlarging and assuming a dark bluish appearance at its prominent part. He complained that the friction employed to preserve the temperature of the limb was only increasing his pain, and the greatest agony was felt in the thigh and knee. Under these circumstances it was resolved no longer to defer the operation.

"*The Operation* had to be performed by candle-light, and, moreover, as he lay in bed, that he might not be put to the pain of being moved before and after it.

"The size and position of the tumour precluding the possibility of reaching the aorta by cutting from the right side of the abdomen, rendered this necessary to be done from the left, which fortunately, at the same time, had the advantage of affording the readiest and easiest access to the vessel, on account of its anatomical situation, but greatly increased the difficulty of reaching the right common iliac, to tie it, which it was hoped might be found possible.

"The patient lying inclined to the right side, the first incision was commenced a little in front of the projecting end of the tenth rib, and carried for more than six inches downwards, in a curvilinear direction, to a point an inch in front of the superior, anterior, spinous process of the ilium, its convexity being towards the spine. The skin, the subcutaneous cellular tissue, and the aponeurosis of the external oblique muscle, were first incised; next the fibres of this muscle; and successively afterwards the layers of the internal oblique and transversalis muscles were displayed and divided; which was found rather a delicate part of the operation, as their fibres contracted spasmodically when touched by the scalpel. The fascia transversalis was now brought beautifully into view, and cautiously divided by a pair of scissors upon a director, to avoid wounding the peritoneum. This membrane being now completely laid bare to nearly the whole extent of the external wounds, was next detached from the fascia covering the iliacus internus, and psoæ muscles, chiefly by the hand, introduced flat between these parts, to separate the loose cellular substance connecting them, which was easily effected.

"Whilst detaching the peritoneum in the fossa of the psoæ, I

found my fingers get into a soft pulpy mass, and a good deal of dark bloody fluid began to ooze out by the side of my hand, which made me withdraw it and examine the parts, by throwing a ray of candle-light into the bottom of the wound, when, from the dark appearance of the parts, my first impression was that they were in a gangrenous state; but I soon discovered that it was caused by ecchymosis, or effusion of bloody serum into the loose cellular texture. I then re-introduced my hand, and gradually prosecuted the detaching of the peritoneum in the direction of the spine, till I came to a large pulsating vessel, which I found to be the upper part of the left common iliac, and in another minute the aorta itself was under my finger; to satisfy myself of which, I requested one of the gentlemen assisting me to place his ear on the tumour, and his hand on the left femoral artery, when he heard and felt the pulsation to stop, and recommence in each, as I compressed the vessel, or the contrary. I now endeavoured to reach the right common iliac, but found that the walls of the tumour extended nearly close up to the bifurcation of the aorta; and even had this obstacle not existed, I do not think there is scope for the hand to perform the necessary manipulations to place a ligature upon that vessel from the left side, without using a degree of force, and causing a laceration of parts, that would be inconsistent with due professional caution, humanity, and judgment.

"A tedious and rather difficult part of the operation succeeded; viz. the making a division in the aortic plexus of nerves, and in the membranous sheath covering the aorta, to get betwixt the vessel and the spine, which I effected partly by the steel end of an elevator cranii, but chiefly by my nails, *with my mind at my fingers' ends;* and I was not a little rejoiced when I had got a sufficient separation to be able to insert the point of the aneurismal needle beyond and behind it; after which I was soon able to get it, with the ligature, round the vessel, without including any portion of nerve or other extraneous substance. In this manœuvre, it was with difficulty that the longest-handled aneurismal needle could be made to reach the necessary depth. The ends of the ligatures being brought out, the aorta was gently raised upon it, which enabled us, by holding up the peritoneal bag, to see this great vessel pulsating at an awful rate.

"The noose of the ligature was then gradually tightened till all pulsation and circulation was found to have decidedly ceased in the left groin; and we anxiously watched the general effect upon the patient whilst this and the second knot were being tied.

"The pulse at the wrist, during the time, underwent no sensible alteration either in strength, fulness, or frequency; nor did the vascular organisation of the head seem to be abnormally congested or excited by the sudden check to this great stream of the circulation. The tightening of the knot did not seem to occasion him any great pain, nor to cause any unusual sensation or shock in the vascular, nervous, or respiratory systems. His first complaint was, that his left leg had become as benumbed and useless as his right, and that we had done him bad service in laming his good leg, which he did not expect, and lamented it bitterly; and on feeling the aorta, it was found to be full, and pulsating, with very great strength, above the ligature, but empty and motionless below it. The ends of the ligature were now brought out exteriorly, and the lips of the wound drawn together by three sutures and adhesive straps, over which a compress and bandage were applied.

"The operation was more tedious than difficult; and being effected chiefly out of sight by the hand, it had not the terrific appearance which that by the method of cutting into the cavity of the abdomen must have, and it was accomplished with the loss of less than two ounces of blood. At one time, during its performance, he required to get some brandy and water to support him; but when it was over, he seemed quite as well as before its commencement; and the pulse was 128, steady and regular."

After the operation he felt deadness of left thigh and leg, and complained of painful distension of the bladder, though it was empty. Afterwards he became easier, and smoked a cigar, and slept a little at intervals. Soon, however, he began to complain of violent pain in the pubic region and loins. Tongue was now dry and dark, strong pulsation of the carotid, and feeble pulse at the wrist, followed by jactitation: cold clammy sweats. No natural warmth ever returned to the lower limbs, and he died twenty-three hours after the operation. On dissection, it was found that the artery had been secured opposite the interval between the fourth and fifth lumbar vertebræ; no extraneous sub-

stance was included, and "the aortic plexus of nerves had been accurately divided." Specks of ulceration were observed on the mucous membrane of the bladder.

The vessels of the lower part of the body having been injected, a few drops of the size injection were found in a small anastomosing vessel, discovered passing between the inferior mesenteric artery and left internal iliac: it arose about 2½ inches below the origin of the mesenteric artery, (from the hæmorrhoidal branch of it, which seemed larger than usual,) and joined one of the upper branches of the internal iliac, being in length about 2 inches; but its calibre was so small, having only admitted two or three drops of the coloured size, that it probably never carried red blood during life. No corresponding vessel was to be found on the right side, nor could any further anastomoses be discovered between the arteries of the abdominal aorta and those of the pelvis or lower extremities. The branches of the thoracic aorta were not injected, and therefore not examined. — *See London Med. Gaz. Oct.* 4. 1834.

The foregoing cases suggest the following considerations: — 1st, That in certain wounds the ligature of the aorta may be employed with success; — 2dly, That in aneurism it can only be had recourse to in order to prolong life for a few days, as no surgeon would venture to propose so serious an operation for an early aneurism; and, in an old one, it will in all probability fail; — 3dly, Dr. Murray's case shows that the aorta may be generally tied, without wounding the peritoneum; and, lastly, I may observe, that Velpeau's plan of tying it above the origin of the inferior mesenteric artery deserves a trial.

The branches of the abdominal aorta are from above downwards — the inferior phrenic, the cœliac axis, superior mesenteric, capsular, renal, spermatic, inferior mesenteric, and middle sacral; to which may be added, the eight lumbar arteries, one being given off on each side, opposite to each of the four first lumbar vertebræ.

I shall describe them, however, in the order in which they should be dissected.

### The Cœliac Axis

May be exposed in the manner advised in the note.* It arises opposite the body of the twelfth dorsal vertebra, takes a direction downwards, forwards, and more frequently to the left than to the right side. After a course of about half an inch, it terminates by dividing into the gastric, hepatic, and splenic arteries. This vessel has the superior margin of the pancreas beneath it: on its sides are the crura of the diaphragm and semilunar ganglia, and in front of it stands the lesser omentum. The Spigelian lobe of the liver is above and to its right side, and the filaments composing the solar plexus surround it.

*Varieties.* — The cœliac axis may be deficient (*Otto*), or may give off only the hepatic and splenic arteries, or the hepatic, splenic, and capsular; or may, in addition to its usual branches, give off the phrenic and gastro-epiploica dextra (*Weber*), or the superior mesenteric (*Geddings*).

### *The Gastric Artery,*

Smaller than the hepatic or splenic, proceeds at first upwards, forwards, and to the left side, to reach the cardiac orifice of the stomach. Here it often sends a large branch to the left lobe of the liver; but its constant branches, are — first, some *coronary branches*, that surround the cardiac orifice; secondly, an *œsophageal*

* By drawing up the liver and depressing the stomach, the gastro-splenic or lesser omentum, which connects them, is brought into view. The anterior layer of this process being divided, the hepatic vessels are exposed, and the hepatic artery may be easily traced to its origin from the cœliac axis.

*branch*, which ascends behind the œsophagus, supplies this tube, and anastomoses with the œsophageal branches of the thoracic aorta; and, thirdly, a long branch, that follows the lesser curvature of the stomach, lying between the layers of the lesser omentum, and sends numerous divisions over both surfaces of the stomach, and communicates with the arteries running along its convex margin. Having arrived near the pylorus, it terminates in anastomosing with the superior pyloric, which is a branch of the hepatic artery.

We shall find that not the gastric only, but the three divisions of the cœliac axis supply the stomach, so that its margin is in fact circumscribed by vessels. The gastric branches of these vessels are situated between the layers of the peritoneum, and are not in contact with the margin of the stomach, unless in its distended state. This observation does not apply to the minute divisions which ramify on both surfaces.

*Varieties.* — The gastric artery has been found arising from the aorta, in common with one of the phrenics (*Geddings*); and it very frequently gives a branch to the liver.

### *The Hepatic Artery*

Is smaller than the splenic in the adult, but larger in the fœtus. It proceeds at first almost transversely along the superior margin of the pancreas, and beneath the Spigelian lobe of the liver, to get behind the pyloric extremity of the stomach. Here it gives off two branches, viz. the pylorica superior and gastro-duodenalis, and then proceeds (involved in the capsule of Glisson) upwards, forwards, and to the right side, having the vena portæ behind it, and the ductus

choledocus to its right side. Having arrived in this manner within about an inch of the liver, it terminates by dividing into the right and left hepatic arteries, having previously given off the superior pyloric and gastro-duodenalis.

*The superior Pyloric Artery* sometimes comes from the right hepatic: it is small, and descends from right to left along the lesser curvature of the stomach. It supplies this organ, and anastomoses with the descending branch of the gastric artery, and with the arteries running along the great curvature of the stomach.

*The Gastro-duodenalis Artery*, about two inches in length, descends behind the first portion of the duodenum, which it separates from the head of the pancreas, and divides into the gastro-epiploica dextra, and the pancreatico-duodenalis. *The Gastro-epiploica dextra*, considerably larger than the latter, proceeds from right to left along the greater curvature of the stomach, both surfaces of which it supplies, and terminates in anastomosing with the gastro-epiploica sinistra, which is a branch of the splenic: its stomachic branches anastomose with the superior pyloric and gastric artery, and with the vasa brevia, while some other long straight branches descend from its convexity, between the layers of the great omentum, to supply the transverse colon. *The Pancreatico-duodenalis*, very small, decends between the pancreas and second portion of the duodenum, supplies both of these, and sends a delicate branch between the inferior margin of the pancreas, and third portion of

the duodenum, to anastomose with the superior mesenteric artery.

*The right terminating Branch of the Hepatic Artery* ascends between the hepatic duct in front, and the right branch of the vena portæ posteriorly, and sinks into the right extremity of the transverse fissure, to supply the liver. Immediately after passing the hepatic duct, it gives off *the cystic artery*, which ascends between the hepatic and cystic ducts, and divides into two branches; one of which is distributed on the superior, and the other on the inferior surface of the gall bladder.

*The left terminating Branch of the Hepatic Artery*, smaller than the right, usually ascends in front of the left branch of the vena portæ, and sinks into the left extremity of the transverse fissure, to supply the liver.

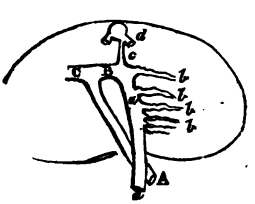
*The Hepatic Artery* has been said by Dr. Mills to be wanting altogether; I doubt if the Doctor examined this case with sufficient attention. There may be two hepatic arteries; one from the cœliac axis, and the other from the aorta or gastric artery. The hepatic artery may come directly from the aorta (*Meckel*), or from the superior mesenteric artery. Lastly, accessory branches from the renal or other sources may be expended on the liver.

The Vena Portæ is formed by the junction of the splenic and superior mesenteric veins, and commences on the front of the aorta, behind the superior margin of the pancreas, and opposite to the first lumbar vertebra. It then takes a direction upwards, and to the right side, to reach the transverse fissure, in which it divides into a right and left branch. In this course it is at first behind and between the hepatic artery and ductus choledocus, and higher up is

directly behind them. In the adult, the right branch, shorter than the left, sinks into the right extremity of the transverse fissure, to supply the right lobe, and the left proceeds in the opposite direction, to supply the left lobe. I now proceed to explain the distribution of these vessels in the fœtus, and the manner in which the subsequent change is effected.

*The Umbilical Vein in the fœtus* ascends obliquely upwards, backwards, and to the right side in the posterior or free margin of the falciform ligament. Having arrived in the umbilical fissure, it sends several branches to the left lobe; then continuing its course backwards, receives the left branch of the vena portæ. Having received this branch, it passes between the Spigelian and left lobes of the liver (receiving in this part of its course the name of *the ductus venosus*), and terminates in the inferior cava, or left hepatic vein.

*The Vena Portæ in the fœtus* divides into two branches; one of which sinks into the right lobe, and the other (instead of going to the left lobe) terminates in the umbilical vein. The annexed figure represents the relative position of these vessels, as they would appear if the fœtal liver was transparent, and the vessels seen through it from above downwards.

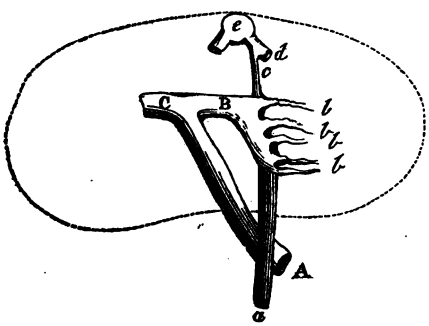



A represents the course of the vena portæ, which passes obliquely upwards and to the right side, and divides into a right branch c, for the right lobe of the liver, and a left branch B, which does not go directly to the left lobe, but terminates in the umbilical vein *a*. The umbilical vein *a* having arrived in the umbilical fissure, gives branches *b b b b*, to the left lobe, and then becoming much contracted, continues its course backwards, under the name of ductus venosus *c*, to open into the left hepatic vein *d*.

From this view it is clear that in the fœtus (if we omit the arteries) the right lobe receives blood from the vena portæ only, but the left from both the portal and umbilical vein. This explains

why the left lobe is so well developed at this period. Now, after birth, the ductus venosus becomes entirely obliterated, but of the umbilical vein its left branches and a part of its trunk remain pervious, viz. that part of it in the immediate neighbourhood of the transverse fissure, for otherwise there would be no way for the blood of the portæ to arrive at the left lobe of the liver. All the rest of the umbilical vein is obliterated.

The subjoined wood-cut will make this more easily understood. *e* is the inferior cava receiving the left hepatic vein *d*, and *c* is the ductus venosus, which is now become impervious. A great portion of the umbilical vein *a* is also obliterated, namely, the shaded portion; the rest serves, by its branches *b b b b*, to transmit the blood of the left branch of the vena portæ B to the left lobe of the liver.




The use generally ascribed to the vena portæ is to convey to the liver the materials for the secretion. Some, however, insist that the bile is secreted from arterial blood; and others, as Mr. Phillips, that it may be indifferently secreted from either: the question is still undecided. In favour of the secretion from the portal blood, it has been said that the bile is of an oily character, and that the venous blood, being highly charged with carbon and hydrogen, is the best suited for its production. To this it has been justly replied, that the fat is separated by exhalation from the arterial blood. Again, the size of the vena portæ is said by those who suppose the bile derived from it, to be suited to the size of the liver; while the other party reply, that the vessel should be compared with the duct and not with the gland; and they

maintain that there is a proper proportion between the size of the hepatic artery and hepatic duct. There are at least four* cases on record, in which the vena portæ did not go at all to the liver, but terminated in the inferior cava. It would appear, however, that in one of these cases the portal system of the liver was not absent, but the peculiarity was, that it commenced in a cul de sac. The same would probably be found in the other cases if they had been accurately examined: to this we shall return hereafter. In pigeons there can be no doubt that the bile is secreted from the portal blood. Mr. Simon found, that if the hepatic artery be tied in these animals, the secretion of the bile continues; if the portal vein and ducts be tied, it ceases; and if the ducts alone be tied, the liver is gorged with bile. Mr. Phillips infers from his experiments, that the blood may be secreted from the blood of either artery or vein, as, whichever vessel was tied, the secretion continued.

I shall here take the opportunity of acquainting the student with some of Mr. Kiernan's valuable observations concerning the circulation and structure of the liver. Previous to his researches, it was supposed that the liver consisted of two different kinds of substance, termed *the red tissue* and *the yellow tissue*. Mr. Kiernan, however, by a series of well-conducted experiments, has shown that the red colour depends on congestion, and the yellow colour on the absence of it. In order to make this more clear, let us attend to his exposition of the structure and arrangement of vessels in the liver. According to Mr. Kiernan, each lobule of the liver has a conical form, and through its axis passes a small vein (therefore termed an *intra-lobular vein*). This vein terminates at a right angle in a larger vein, which is applied to *the base* of the lobule: (this is accordingly called a *sub-lobular vein*). The sub-lobular veins terminate in the hepatic veins, and these again in the inferior cava. Now, all that portion of the exterior of a lobule, which does not constitute its base, is termed its *capsular surface*, because it is in contact with, and separated from,

* Lieutaud, Hist. Anat. Méd. tom. i. p. 190.
Huber, Observ. Anat. p. 34.
Abernethy, Phil. Trans. 1793.
Lawrence, Med. Chirurg. Trans. vol. v. p. 174.

the surrounding lobules by processes of the capsule of Glisson. These processes are (like the pia mater) cellulo-vascular layers, which accompany the branches of those vessels that enter or escape at the transverse fissure, namely, the artery, duct, and portal vein: the divisions of these three sets of vessels form a kind of circumferential investment, covering the capsular surfaces of the lobules; and by taking each of them separately, we shall find how they are afterwards disposed of. First, the ducts penetrate the capsular surfaces of the lobules, and form in the interior of each an extensive *biliary plexus*: these ducts only communicate with each other, and are not, as formerly supposed, continuous with the vascular capillaries of any other system. Secondly, branches of the hepatic artery also penetrate the capsular surface of the lobules: they supply the parenchyma of the lobules, and the coats of all the vessels; and the surplus of blood not required for the nutrition of these parts is disposed of in a twofold way: part of it is conveyed by the intra-lobular and sub-lobular veins to the inferior cava; and another portion of it gets into the portal system. Thirdly, the portal veins, after piercing the capsular surface of the lobules, form, in its interior, a *portal plexus*, which, having received, as above mentioned, part of the blood conveyed by the arteries, sends branches to ramify on the coats of the biliary plexus, and secrete the bile. Hence it appears that the bile is not secreted from arterial blood, but from venous blood derived from two different sources; and that the branches of the vena portæ act as veins to the hepatic artery, and as arteries to the hepatic veins, which receive the surplus of blood not employed in secretion. Now the appearances of yellow and red tissue can be readily explained. The red tissue is owing to venous congestion; when this occurs in the hepatic system of veins, the centre of each lobule will be dark from engorgement of the intra-lobular veins, and, *vice versâ*, when the congestion occurs in the portal system, the centre of the lobule will be light (constituting the yellow tissue), but the circumference red, by engorgement of the portal veins investing it: so that in one case, we shall have dark spots on a pale ground; and in the other, pale spots on a dark ground. Mr. Kiernan could produce these appearances at pleasure, in experiments on animals, both in the liver, and also in the kidneys of those animals that have a portal renal circulation.

### *The Splenic Artery*

Proceeds from right to left, in a very tortuous manner, along the superior margin of the pancreas. Posterior to it is the left crus of the diaphragm and psoas muscle; the stomach covers it in front, and the splenic vein is parallel and inferior to it. On approaching the spleen, it divides into five or six branches, which enter the fissure on its concave surface. The branches given off by the splenic artery in this course are, first, small branches (*pancreaticæ parvæ*), variable in number to the pancreas: secondly, a large branch to the pancreas (*pancreatica magna*), which sometimes accompanies the duct of this gland, but is often deficient: thirdly, the *vasa brevia* (some of which come from the trunk of the splenic, and others from the branches that enter the spleen); they are five or six in number, and are reflected to the bulging extremity of the stomach, where they communicate freely with the other arteries supplying this organ: lastly, the gastro-epiploica sinistra arises from one of the terminating branches of the splenic, and proceeds from left to right along the great curvature of the stomach, to anastomose with the gastro-epiploica dextra (p. 156.), and give off similar ascending and descending branches.

When the arteries penetrate the spleen, they soon break abruptly into numerous fine branches, compared to the hairs of a camel-hair pencil: these branches do not communicate with each other, but terminate in veins that form numerous plexuses. There are no cells in the spleen as formerly represented. The following passage, describing their disposition in the spleen, is extracted from Baly's translation of Muller.

"The spleen is invested by a strong, fibrous membrane, which sends numerous band-like processes into its interior, so as to support the soft, pulpy, red tissue of the organ. In the red substance there are in many animals contained whitish, round corpuscules, visible by the naked eye, which were first discovered by Malpighi, and of which the existence in the human spleen has been at one time admitted, at another denied.

"The red pulpy substance consists of a mass of red-brown granules, as large as the red particles of the blood, but differing from them in form, being irregularly globular,—not flattened. These granules are easily separable from each other. In the mass which they form, the minute arteries ramify in tufts, and terminate in the plexus of venous canals, into which all the blood of the spleen is poured before it is carried out of the organ by the splenic vein. The anastomosing venous radicles, which are of considerable size, appear to have scarcely any distinct coats. If a portion of the pulpy substance of the spleen is examined more closely, it is seen to be everywhere perforated with small foramina, which are spaces bounded by the reticulated substance of the organ. These spaces are venous canals: on inflating them, the organ acquires a cellular appearance; and if they are injected with wax, the substance of the spleen will present a great resemblance to the corpora cavernosa penis. There are no true cells in the spleen. The white corpuscules are imbedded in the pulpy substance, and not contained in cells, as Malpighi supposed. A fibrous trabecular tissue intersects in all directions the very soft pulpy red substance, and affords support to the texture of the organ."

Cruveilhier observes, that if we inject the arteries of the spleen, it enlarges slowly; but if we inject the veins, it enlarges at once,— showing that the connection between the arteries and the venous plexus is not so free as between the latter and the veins.

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## The Superior Mesenteric Artery,

Nearly as large as the cœliac axis, and sometimes larger, arises from the aorta, about a quarter of an inch lower down. It first descends a little to the left, behind the splenic vein and pancreas, and on the front of

the abdominal aorta. Having reached the lower margin of the pancreas, it becomes separated from the aorta by the third portion of the duodenum and left renal vein. In the next part of its course it descends behind the transverse mesocolon, and then between the laminæ of the mesentery, to arrive at the ileum, near its termination; it then ascends along this intestine towards the cœcum. In this course it has its vein to its right side, and it describes a curvature, the convexity of which looks downwards and to the left side. It first gives small branches to the pancreas and duodenum, which anastomose with the pancreatico-duodenalis artery. Lower down it gives off two sets of branches, viz. one from its convexity, or left side; the other from its concavity, or right side.

1st. *The Branches from the Convexity* are fifteen to twenty in number: they are contained between the layers of the mesentery, and destined for the ileum, jejeunum, and third portion of the duodenum. Each of them, after a short course, divides into two branches, which anastomose with the branches of the adjacent arteries, so as to form a series of arches. From the convexities of these, smaller arteries arise, which likewise bifurcate, forming a second and lesser series of arches with those adjacent; and in the same manner a third and fourth, and, in some cases, a fifth series is formed, gradually approaching the intestine, and diminishing in size. The entire set present an areolar appearance in the mesentery; and when the ultimate branches (which advance in straight lines) reach the intestine for which they are destined, they encircle it,

and form a delicate vascular stratum in its sub-mucous cellular tissue.

2dly. *The Branches from the Concavity* are three in number: they are considerably longer than the preceding: they are contained between the layers of the mesocolon, and destined to supply the right and transverse colon.

*The first Branch, or Colica Media,* goes horizontally forward between the laminæ of the transverse mesocolon, and soon divides into a right and a left branch; the former of which anastomoses with the superior branch of the colica dextra, and the latter with the superior branch of the colica sinistra (which is itself a branch of the inferior mesenteric).

*The second Branch, or Colica Dextra,* ascends a little to the right, towards the superior part of the right colon, near which it divides into,—a superior branch, which anastomoses with the right branch of the colica media; and an inferior branch, which descends to anastomose with the superior branch of the ileo-colic artery.

*The third, or Ileo-colic Branch,* arises below the preceding, and runs downwards, and to the right side, towards the cœcum. Before it reaches the intestine, however, it divides into three branches,—the superior of which ascends to anastomose with the colica dextra; the inferior descends to anastomose with the termination of the superior mesenteric artery; while the middle branch passes behind the cœcum, and terminates in supplying the ileum, cœcum, and vermiform appendix.

In the fœtus, the superior mesenteric artery gives off an *omphalo-mesenteric branch*, which proceeds along the umbilical cord to be lost on the vesicula umbilicalis. It is usually obliterated at the end of the second month, but Cruveilhier saw it in an acephalous fœtus at the ninth month.

*Varieties.*—The superior mesenteric artery sometimes arises in common with the cœliac axis. It has been known to give off an hepatic artery, and, in another case, it gave off the gastro-epiploica dextra.

The superior mesenteric arteries may be absent (*Wehrde*), or its branches may not anastomose with those of the inferior mesenteric artery (*Vicq D'Azyr*); or it may be double. Other varieties as to its origin and branches have been already noticed.

There is a case on record in which the duodenum was ruptured opposite the point where it is constricted by the superior mesenteric artery.

### The Inferior Mesenteric Artery,

Smaller than the preceding, arises from the anterior and left part of the aorta, about an inch and a half above its bifurcation. It first descends on the aorta, between the layers of the mesocolon, and then turns over the left common iliac artery to terminate behind the rectum. This terminating branch is termed the superior hæmorrhoidal. In the above course, the inferior mesenteric artery forms an arch, the convexity of which looks to the left side. Its branches are three in number.

1. *The Colica Sinistra* ascends between the layers of the left mesocolon, and divides into a superior and inferior branch; the former anastomoses with the colica media, and the latter with the sigmoid artery.

*The Sigmoid Artery* crosses the front of the psoas muscle, and divides into a superior branch, which communicates with the colica sinistra, and an inferior

branch, which terminates in the sigmoid flexure of the colon. This artery also supplies the psoas and iliacus muscles and the ureter.

*The superior Hæmorrhoidal Artery* cannot be well examined till the arteries of the pelvis have been dissected. If we suppose the rectum divided into three stages, — a superior, middle, and inferior, — we find that in the first stage it is entirely surrounded with peritoneun, and has a meso-rectum: in the second stage it has no meso-rectum, and it is covered by peritoneum upon its anterior part only, and a portion of the sides: in the third stage it has no peritoneal covering. Now we find the artery distributed in conformity with this arrangement; for in the superior stage it descends as a single trunk between the layers of the meso-rectum; it then divides, about four inches from the anus, into two branches: and these, in the second stage, follow (one on either side) the line of reflection of the peritoneum from the side of the rectum: lastly, in the third stage its branches are numerous, and distributed all round the inferior extremity of the intestine. The superior hæmorrhoidal artery communicates freely with the hæmorrhoidal branches of the internal iliac and pudic arteries.

For *varieties* accidentally omitted, see Appendix.

In case of hæmorrhage into the rectum from the hæmorrhoidal arteries, the most effectual way to suppress it is to introduce a membranous tube closed at one end, and through the other with a syringe inject cold water sufficient to distend it, and compress the surface of the gut. The water can be occasionally renewed without withdrawing the tube.

The liver, stomach, spleen, and intestines may now be examined and removed, after which we proceed with the dissection of the deeper branches.

### The Inferior Phrenic Artery

Is the first branch of the abdominal aorta, and arises immediately above the cœliac axis. On the right side it passes upward, forward, and outward, between the right crus of the diaphragm, which is behind it, and the inferior cava, which is in front. On the left side it takes a similar direction, separating the left crus of the diaphragm from the œsophagus. Having arrived at the posterior extremity of the cordiform tendon of the diaphragm, it communicates behind this tendon with that of the opposite side, and then divides into external and anterior branches: these ramify in the substance of the diaphragm, and inosculate with the branches of the superior phrenic,—that of the right side sending branches to the liver through its coronary ligament, and that of the left side sending a branch to the œsophagus. Finally, the external branches anastomose with the intercostal arteries; and the anterior branches communicate with the internal mammary, and with the branches of the opposite side, in front of the cordiform tendon. In this manner there is a kind of arterial circle formed around the tendon.

Soon after its origin, the inferior phrenic gives a *superior capsular branch* to the super-renal capsule.

*Varieties.*—Both phrenics have been found arising by a common origin from the right emulgent (*Green*).

The inferior phrenic arteries may arise by a common origin from the aorta, or one or both may come from the cæliac axis. Sometimes it arises from the first lumbar, and rarely from the gastric or renal. (*Haller.*)

### The Middle Capsular Arteries

Are usually two in number, viz. one on each side. and arise from the aorta a little above the renal. Each of them proceeds transversely outwards, to arrive at the concave margin of the corresponding super-renal capsule, and divides into a number of branches that ramify in the sinuosities on its anterior and posterior surface, and in its interior. In this course it gives a few branches to the pillars of the diaphragm, and to the psoas muscle and adipose cellular tissue.

These arteries are very small in the adult, but as large as the renal in the fœtus. There are often three or four of them. The student will perceive that the super-renal capsules have arteries from three different sources, viz. from the inferior phrenic, from the aorta, and from the renal.

### The Renal Arteries

Are usually two in number, viz. one on each side. They arise from the aorta opposite to about the second lumbar vertebra: sometimes the left arises a little higher than the right. After their origin, each of them proceeds at nearly a right angle towards the corresponding kidney. *The right renal artery* is longer than the left on account of having its origin on

the left side of the spine: *posteriorly* it rests on the spine, right sympathetic nerve, and psoas muscle; *anteriorly* it is covered by the left renal vein, the inferior cava, and the right renal vein. Its branches, four or five in number, penetrate the pelvis of the kidney between the branches of the vein which are in front, and the ureter which is posterior and inferior.

*The left Renal Artery* lies on a little of the psoas muscle, covered by its corresponding vein. The branches, however, do not usually enter the kidney behind the veins, as on the right side, but in front of them, the ureter lying behind both sets of vessels, and lower down.

The branches of the renal arteries in this course are, first, *inferior capsular* branches to the super-renal capsules; secondly, adipose branches to the surrounding cellular tissue; thirdly, a small branch or two to the ureter, and, lastly, terminating branches. *The Terminating Branches* advance between the conoid bodies, and divide into minute vessels that form a network at the junction of the tubular and cortical substance. From this network set out a vast quantity of branches, most of which terminate in the cortical substance, and a few in the tubular.

In the early period of intra-uterine life, the kidney is formed of a number of independent lobules, each supplied with a distinct set of vessels; and even in the adult there remains so much distinction, that different compartments of the kidney can be injected of different colours.

The renal arteries are liable to many varieties, affecting their number, origin, direction, and branches given off.

*First; Number.*—In some cases there are two on one or both sides (*Hird*); when this occurs on the right side, one branch usually goes behind, and the other in front of the inferior cava. Occasionally there is a distinct artery sent to one of the extremities of the kidneys: this may be either a branch of the renal, or may arise separately from the aorta, internal iliac, or middle sacral (*Otto*), or from the common iliac (*Eustachius*). In a very extraordinary case the kidney was placed transversely in the pelvis, and supplied by the middle sacral artery (*Archives generales Fev.* 1835). Portal saw the right and left arise by a common origin from the aorta. Lastly, the right renal artery and kidney may be absent (*Petsch*). *Secondly; Origin.* The renal artery may arise lower down than usual from the aorta, or may come from the common or internal iliac: this is more likely to occur when the kidney is found in the iliac fossa, as sometimes happens. Cruveilhier has seen an accessory branch, from the bifurcation of the aorta, go to the kidney in this situation. Lastly, Meckel has seen the two renals arise by a common trunk from the front of the aorta. *Thirdly; Direction.* The renal arteries usually form somewhat less than a right angle with the continued trunk; but their direction must obviously vary according as they arise high or low. In some cases in which there were two renal arteries on one side, they were found twisted on each like the umbilical arteries. *Lastly,* the spermatic arteries on one or both sides may come from the renal.

## The Spermatic Arteries

Arise from the aorta a little beneath the renal: each of them descends obliquely outwards over the psoas muscle and ureter, which latter it crosses at an acute angle. On the right side the spermatic artery also crosses the front of the vena cava; sometimes, however, it goes behind it. On the left side the artery passes behind the sigmoid flexure of the colon. In

this course the spermatic veins lie to the outside of the corresponding arteries, and the peritoneum covers it in front. In the rest of their course they differ in the male and female subject.

*In the male*, the spermatic artery enters the inguinal canal, and descends on the front of the vas deferens, making part of the spermatic cord, and becoming extremely tortuous as it approaches its termination. A little above the testis it divides into two branches, one of which enters the head of the epidydimis, while the other penetrates the superior margin of the body of the testis, and repairs to the corpus Highmoranum, from whence they issue in two sets: one set ramify on the internal part of the tunica albuginea*, and detach minute vessels at various points to the tubuli testis; the other set pierce the corpus High-morionun, and descend along the septa of the testicle from its posterior to its anterior margin.

*In the female*, the spermatic artery turns inwards over the common iliac, and passes to the side of the uterus, between the layers of peritoneum composing its broad ligament. It supplies the ovary, Fallopian tube, and uterus, and anastomoses with the proper uterine arteries. In pregnancy, the branches to the uterus become enormously large.

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* Sir A. Cooper describes the tunica albuginea as having two layers,—an outer one analogous to the dura mater, and inner one (in which the vessels ramify) analogous to the pia mater. Cruveilhier disapproves of this description, and thinks the vessels of the tunica albuginea are more analogous to the sinuses of the dura mater.

*The Veins* that accompany the spermatic artery arise from the testis and epidydimis, and form a plexus immediately after their junction. They then ascend, four or five in number, through the inguinal canal, lying in front of the vas deferens, and ultimately unite, in the lower part of the lumbar region, into a single trunk that ascends on the outside of the artery. In some cases this single vein divides again into many branches so as to form a peculiar plexus, termed *the pampiniform plexus;* after which it again becomes a single trunk. Meckel says the plexus exists more frequently on the left side than on the right. When there are two spermatic veins on one side, they communicate frequently across the artery which lies between them. As the left testicle is lower than the right, the veins are longer; and this is supposed to explain, why a varicose state of these vessels is not as frequent on the right side as on the left.

In the male fœtus these arteries are proportionably very short, as the testicle is then placed within the abdomen, but they subsequently elongate as the testicle descends. The spermatic arteries are remarkable for increasing in diameter as they recede from their origin: to this fact I have already directed the student's attention. In the operation of castration the spermatic artery is apt to retract considerably on being divided, so as to render it difficult to secure it in a ligature. The surgeon may avoid this embarrassment by holding the divided cord in his hand till an assistant draws out and secures whatever branches are necessary. The exquisitely painful practice of including the vas deferens in the ligature is now universally abandoned.

*Varieties.* — The spermatic artery on one or both sides may come from the renal: this is more likely to occur on the right side than on the left. Sometimes they arise from the aorta by a

common trunk; and Cruveilhier has seen the left one arise from the aorta as low down as the inferior mesenteric.

The spermatic artery may likewise arise from the capsular (*Haller*), or from the external iliac or internal iliac (*Mayer*), or from the lumbar, or even from the epigastric (*Meckel*).

## The Lumbar Arteries

Are generally four in number on each side; sometimes, however, we meet five, and sometimes only three. They are larger than the intercostal, to which they are analogous. Each of them arises from the posterior and lateral part of the aorta, and passes outwards on the body of the corresponding vertebra, and then behind the sympathetic nerve and psoas muscle. Those that are sufficiently high also pass behind the corresponding pillar of the diaphragm. The upper ones are also more nearly horizontal; while the lower descend with a gradually increasing obliquity. Opposite the corresponding transverse process, each of them divides into an anterior and posterior branch.

*The Anterior Branch*, smaller than the posterior, passes outwards between the psoas and quadratus muscles, and then between the quadratus and anterior layer of the transversalis tendon. The anterior branch of the first lumbar passes outwards beneath the last rib, and along the insertion of the diaphragm, and then on front of the quadratus lumborum. It communicates with the intercostal arteries. The anterior branch of the fourth follows the attachment of the quadratus lumborum to the crest of the ilium, and

communicates with the ilio-lumbar. All the anterior branches, moreover, communicate with the adjacent ones, and supply the quadratus lumborum and broad muscles of the abdomen.

*The Posterior Branch* of each lumbar artery sends a small vessel through the corresponding lateral foramen of the spine, to be lost in the spinal marrow and its tunics, and then expends itself in the lumbar mass of muscles, and in the integuments.

### The middle Sacral Artery,

Usually smaller than the lumbar arteries, arises from the posterior part of the aorta a little above its bifurcation; it then descends on the front of the spine, and on the middle line of the sacrum, being covered in front by the aorta, left common iliac vein, and by the pelvic viscera. It is separated from the lateral sacral of either side by the corresponding trunk of the sympathetic nerve. Inferiorly it terminates by dividing into two branches right and left, which communicate, in the form of a double arch, with the right and left lateral sacral arteries. Opposite each bone of the sacrum this artery sends off transverse branches to either side, which supply the periosteum, and communicate with the lateral sacral and hæmorrhoidal arteries.

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### The common Iliac Arteries.

On the left side of the fourth lumbar vertebra (and nearly opposite the left margin of the umbilicus), the

aorta bifurcates into the right and left common iliacs. These diverge as they descend, leaving an angle between them wider in the female than the male.

*The right common iliac* descends obliquely to the right side, till it reaches the superior extremity of the sacro-iliac symphysis. *Its posterior surface* in this course lies on the fifth lumbar vertebra, on the bifurcation of the inferior cava, and on both the left and right common iliac veins. Its right or corresponding vein consequently lies behind it, projecting above to its outside, but below to its inside, as represented in the accompanying figure. The obturator and sympathetic nerves also descend behind it into the pelvis. *Its anterior surface* is crossed at its bifurcation by the ureter, and is covered by the last coil of the ilium, as it ascends from the true pelvis to join the cæcum in the iliac fossa. In the female the spermatic vessels turn over it to reach the uterus.

*The left common iliac artery* descends with less obliquity than the right, and is usually shorter, in consequence of the aorta bifurcating on the left side of the spine. In many cases, however, it will be found longer, a fact that was first pointed out to me by Mr. Adams of Dublin. *Its posterior surface* rests on the fifth lumbar vertebra and outer edge of its corresponding vein: the sympathetic and obturator nerves also descend behind it as on the other side. *Its anterior surface* is crossed by the ureter at its bifurcation, and is covered by the sigmoid flexure of the

colon and the termination of the inferior mesenteric artery. In the female the spermatic vessels are also related to it. It may be observed that the vein on this side is in no part of its course external to the artery, as on the opposite side.

The common iliac arteries give off no branches, except very minute ones to the ureter, peritoneum, iliac veins, and adjacent lymphatic glands. They each of them bifurcate opposite the sacro-iliac symphysis into the external and internal iliacs.

The common iliac artery has been known to give off the middle sacral, also the lateral sacral (*Tiedeman*), and in some cases the ileo-lumbar (*Tiedeman*). I have also referred, already, to cases in which the renal artery arose from it (p. 171.); and to another, in which the inferior mesenteric artery arose from the left common iliac. A case of high division of the aorta is recorded, in which the superior mesenteric came from the internal iliac.

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## OPERATION OF TYING THE COMMON ILIAC ARTERY.

Having already shown that the inferior extremities will receive an adequate supply of blood after the aorta has been tied, we have established *à fortiori*, that there will be a sufficient supply after ligature of one of its branches. This operation of tying the common iliac artery has been twice performed on the human subject for aneurism; first, in March, 1827, by Valentine Mott, of New York; and in the year following by Mr. Crampton, the surgeon-general for Ireland. Mott's case was successful; and as it contains a great deal of important and interesting information, I shall detail it at length. It has been also tried for a wound by Mr. Gibson, of Baltimore.

*Mr. Mott's Case.*—The subject of this operation, Isaac Crane, aged 33, was a man of temperate habits, and his disease was a large aneurismal tumour, of nearly three months' standing; filling the iliac fossa, and extending from a little above Poupart's ligament, to near the umbilicus.

"The patient being placed upon a table of suitable height, the pubes and groin of the right side being shaved, an incision was commenced, just above the external abdominal ring, and carried in a semicircular direction, half an inch above Poupart's ligament, until it terminated a little beyond the anterior superior spinous process of the ilium, making it in extent about five inches. The integuments and superficial fascia were divided, which exposed the tendinous part of the external oblique muscle, upon cutting which, in the whole course of the incision, the muscular fibres of the internal oblique were exposed, the fibres of which were cautiously raised with the forceps, and cut from the upper edge of Poupart's ligament. This exposed the spermatic cord, the cellular covering of which was now raised with the forceps, and divided to an extent sufficient to admit the forefinger of the left hand, to pass upon the cord, into the internal abdominal ring. The finger serving now as a director, enabled me to divide the internal oblique, and transversalis muscles, to the extent of the external incision, while it protected the peritoneum. In the division of the last-mentioned muscles, outwardly, the circumflexa ilei artery was cut through, and it yielded, for a few minutes, a smart bleeding. This, with a smaller artery upon the surface of the internal oblique muscle, between the rings, and one in the integuments, were all that required ligatures.

"With the tumour beating furiously underneath, I now attempted to raise the peritoneum from it, which we found difficult and dangerous, as it was adherent to it in every direction. By degrees we separated it, with great caution, from the aneurismal tumour, which had now bulged up very much into the incision. But we soon found, that the external incision did not enable us to arrive at more than half the extent of the tumour, upwards. It was therefore extended, upwards and backwards, about half an inch, within the ilium, to the distance of three inches, making a wound in all about eight inches in length.

"The separation of the peritoneum was now continued, until the fingers arrived at the upper part of the tumour, which was found to terminate at the going off of the internal iliac artery. The common iliac was next examined, by passing the fingers upon the promontory of the sacrum, and, to the touch, appearing to be sound, we determined to place our ligature upon it, about half way between the aneurism and the aorta, with a view to allow the

length of vessel enough on each side of it, to be united by the adhesive process.

"The great current of blood through the aorta made it necessary to allow as much of the primitive iliac to remain between it and the ligature as possible; and the probable disease of the artery, higher than the aneurism, required that it should not be too low down. The depth of this wound, the size of the aneurism, and the pressure of the intestines downwards, by the efforts to bear pain, made it impossible to see the vessel we wished to tie. By the aid of curved spatulas, such as I used in my operation upon the innominata, together with a thin piece of board, about three inches wide, prepared at the time, we succeeded in keeping up the peritoneal mass, and getting a view of the arteria iliaca communis, on the side of the sacro-vertebral promontory. This required great effort on our part, and could only be continued for a few seconds. The difficulty was greatly augmented by the elevation of the aneurismal tumour, and the interruption it gave to the admission of light.

"When we elevated the pelvis, the tumour obstructed our sight; when we depressed it, the crowding down of the intestines presented another difficulty. In this part of the operation, I was greatly assisted by Dr. Osborn, and my enterprising pupil Adrian A. Kissam. Introducing my right hand, now, behind the peritoneum, the artery was denuded with the nail of the forefinger, and the needle conveying the ligature was introduced, from within outwards, guided with the forefinger of the left hand, in order to avoid injuring the vein. The ligature was very readily passed underneath the artery, but considerable difficulty was experienced in hooking the eye of the needle, from the great depth of the wound, and the impossibility of seeing it. The distance of the artery from the wound was the whole length of my aneurismal needle.

"After drawing the ligature under the artery, we succeeded, by the aid of our spatulas and board, in getting a fair view of it, and were satisfied that it was fairly under the primitive iliac, a little below the bifurcation of the aorta. It was now tied; the knots were readily conveyed up to the artery by the forefingers; all pulsation in the tumour instantly ceased. The ligature upon the artery was a very little below a point opposite the umbilicus."

The wound was dressed in the usual way: the operation lasted

less than an hour. It was performed on the 15th March, and the ligature was removed from the artery on the 3rd April following. On the 20th of May, he made a journey of twenty-five miles.*

*Mr. Crampton's operation.*—The patient died on the eleventh day; and the failure of the operation has been attributed to the employment of a catgut ligature, which (as appeared from examination of the body) either broke from the impulse of the blood, or had rotted away.

When the common iliac artery is interrupted, the internal mammary supplies the limb through the epigastric; the inferior lumbar arteries supply it through the gluteal and ilio lumbar; and the internal iliac of the sound side through the communicating branches of the internal iliac of the diseased side.

The common iliac artery may be reached by the proceeding recommended farther on (p. 182.), for tying the internal iliac.

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### THE INTERNAL ILIAC ARTERY

In the adult descends backwards and inwards along the sacro-iliac symphysis, as far as the superior extremity of the great sacro-sciatic notch; here it becomes ligamentous, and ascends to the umbilicus, on the side of the bladder, forming a part of its superior ligament. In its first, or truly arterial stage, it forms a curvature, the concavity of which looks forwards. Its posterior or convex surface rests on the sacro-iliac symphysis, from which it is separated by its corresponding vein, which projects a little at its outer edge; and by the lumbo-sacral nerve which lies still deeper than the vein. Its anterior surface is crossed superiorly by the ureter, and inferiorly by the vas deferens. Besides these, the

* Johnson's Med. Chir. Review, vol. viii. 1828, p. 472.

rectum covers if on the left side, and the bladder on both.

*The internal iliac artery of the fœtus* differs in many respects from this. First, in the adult, it is considerably smaller, but in the fœtus considerably larger than the external iliac. In the fœtus, it does not descend deep into the pelvis, but rather winds round the ilio-pectineal line, and then ascends not in a ligamentous form, but pervious, and carrying blood along the sides of the bladder to the umbilicus. In the rest of their course, viz. from the umbilicus to the placenta, they form part of the umbilical cord.

*Varieties.*—The umbilical arteries have been known to unite, and form a single trunk; and many cases are recorded, in which the artery of one side was absent. (*Otto.*)

After birth, the internal iliac arteries gradually diminish, and the external iliac arteries and posterior branches of the internal iliac gradually enlarge.

The internal iliac artery may require to be tied in consequence of a wound, or for aneurism of its glutæal or other branches. The operation of tying it has been performed in four instances, in three of which it succeeded. It was first tied by Dr. Stevens of New York (Med. Trans., vol. v. 422.),—the patient recovered; then, unsuccessfully, at the York Hospital, by Mr. Atkinson; afterwards, by a Russian surgeon (Averill's Surg.); and, lastly, by Dr. White (of Hudson, U. S., America), on a tailor, of sixty years. In both these latter cases the operation succeeded.

In *Dr. Stevens* and *Mr. Atkinson*'s cases, the operation was commenced by an incision, five inches long, through the integuments, fascia, and muscle, parallel, and a little external, to the epigastric artery.

*Mr. White* made a similar incision on the side of the abdomen, about seven inches long, with its convexity to the ilium, commencing near the umbilicus, and terminating near the inguinal ring.

The remaining steps, in both cases, consisted in pushing inwards the sac of the peritoneum, and carrying the finger along the external iliac artery, until it reached the origin of the internal iliac.

It is a fact worthy of attention that the ureter invariably accompanies the peritoneum, and if the

latter be kept out of the way, there will be no fear whatever of including the ureter.

*The Operation of tying the Internal Iliac Artery.*

In order to arrive at the internal iliac artery, an incision should be made in a line extending from the umbilicus to midway between the spine of the pubes and the anterior superior spine of the ilium. This incision should commence at the outer edge of the rectus muscle, and terminate about an inch above Poupart's ligament, in order to avoid the spermatic cord. The different muscular layers composing the anterior wall of the abdomen being successively divided, the transversalis fascia should be cautiously scraped through, and the peritoneum exposed and pushed inwards. The fascia covering the vessels should also be torn with the nail, and then, by following the external iliac artery backwards, we arrive at the internal. In the angle between them lies the external iliac vein, which should be carefully avoided, and the needle introduced from within, outwards.

The branches of the internal iliac artery are classed into those that remain within the pelvis and those that leave it to be distributed externally. The former are four in number, viz. the glutæal, sciatic, pudic, and obturator; and the latter, which, in the male, are four in number, are the ilio-lumbar, lateral sacral, hæmorrhoidal, vesical, to which may be added, in the female, the uterine and vaginal.

### *The Glutæal Artery.*

This is the largest branch of the internal iliac. It arises far back in the pelvis, opposite the lowest part of the sacro-iliac symphysis, and immediately passes backwards between the lumbo-sacral and first sacral nerves, and above the pyriform muscle, to escape from the pelvis, in passing through the upper part of the great sacro-sciatic notch. After this very short course, in which it is accompanied by the deep glutæal nerves, it divides opposite the posterior margin of the glutæus minimus, and, under cover of the glutæus maximus, into a superficial and deep branch, having first sent, while in the pelvis, some small offsets to the pyramidal muscle, the rectum, and the cellular tissue.

The *Superficial Branch* ascends between the glutæus maximus and medius, and divides into numerous lesser branches, some of which supply these muscles and the great sacro-sciatic ligament; while others are distributed to the sacro-spinal muscle and integuments. Some of these branches communicate with the sciatic artery.

The *Deep Branch* takes a direction obliquely upwards and forwards between the glutæus medius and minimus muscles. After giving a small *nutritious artery* to the ilium, it divides into two lesser branches; the superior of which follows accurately the inferior curve line that marks the upper margin of the glutæus minimus, supplying, in this course, the last-mentioned muscle and the glutæus medius. Having arrived at the anterior superior spine of the ilium, it anastomoses with

the ilio-lumbar, circumflexa ilii, and external circumflex femoris arteries. The inferior division, sometimes consisting of two vessels, runs downwards and forwards between the two lesser glutæi muscles, which receive many branches from it, and having arrived at the great trochanter, supply the pyramidal muscle and capsule of the hip joint, and communicate with branches of the sciatic and internal circumflex femoris arteries.

Mr. Lizars (see his Anatomy, note, page 106.) gives the following rule for finding the trunk of the glutæal artery. Draw a line from the posterior spinous process of the ilium to the mid-point between the tuberosity of the ischium and the great trochanter; and then divide this line into three equal parts; the glutæal artery will be found emerging from the pelvis, at the juncture of its upper and middle thirds. It will hardly ever be necessary, however, to apply this rule, unless for the purpose of avoiding it in opening deep abscesses of the glutæal region. For, in case of a wound, we must be guided by the wound itself; and, in case of glutæal aneurism, we should tie the internal iliac artery, as in the cases related in the Medico-Chirurgical Transactions, vol. v. p. 422; and in the Medical and Physical Journal, vol. xxviii. p. 207. The opposite practice has, no doubt, been successful: thus, Mr. Bell (see his Principles of Surgery, vol. i. p. 421.) cut down on the tumour, in a case of glutæal aneurism, opened the sac, and tied the vessel successfully. It is not, however, an operation likely to succeed generally; and, should it not succeed, a second severe operation becomes immediately necessary.

### *The Sciatic Artery.*

The *Sciatic Artery* (or Ischiatic), smaller than the glutæal, descends on the front of the sacral plexus and pyramidalis muscle. In this course it passes between the rectum and outer wall of the true pelvis, and is accompanied by the pudic artery, which is first external to it, and then crosses to its inside opposite the spine of the ischium. In company with the pudic

artery it escapes from the pelvis through the inferior part of the great sacro-sciatic notch in passing between the lower edge of the pyramidalis muscle and the lesser sacro-sciatic ligament. At its exit it is covered by the glutæus maximus muscle and the great sacro-sciatic nerve. While within the pelvis it gives small branches to the bladder, rectum, uterus, and levator ani muscle. After it leaves the pelvis, it terminates by giving off the muscular and coccygeal branches and a branch to the sciatic nerve.

The *Muscular Branches* are distributed to the glutæus maximus, quadratus femoris, and hamstring muscles, and anastomose with the internal circumflex and perforating arteries.

The *Coccygeal Branch* passes inwards between the origins of the greater and lesser sacro-sciatic ligaments; it supplies the glutæus maximus, levator ani, and ischior coccygeal muscles, and periosteum of the coccyx, and anastomoses with the anterior spinal and with the middle and lateral sacral arteries.

The *Comes Nervi Ischiatici* appears like the terminating branch. It first descends along the internal margin of the great sciatic nerve, and then penetrates its substance. Boyer found the branch as large as the radial at the wrist in a subject that Dessault had operated on eight months before for popliteal aneurism.

According to Mr. Lizars, the exit of the ischiatic artery from the pelvis may be found by placing the patient on his face, with the toes turned out, and drawing a line from the posterior superior spine of the ilium to the fossa, between the tuberosity of the ischium and great trochanter (but a little nearer to the former): the exit of the artery will be found opposite the centre of this line.

### *The Obturator Artery.*

This is the smallest and most anterior of the four branches of the internal iliac that go out of the pelvis. It runs downwards and forwards, to pass through the upper part of the obturator foramen. In this course it is accompanied by a nerve * which lies above, and a vein that lies beneath it, and communicates with that of the opposite side by a branch crossing transversely behind the body of the pubes. Having passed through the obturator foramen, it lies on the obturator externus muscle, covered by the pectineus, and there divides into two branches, an anterior and posterior.

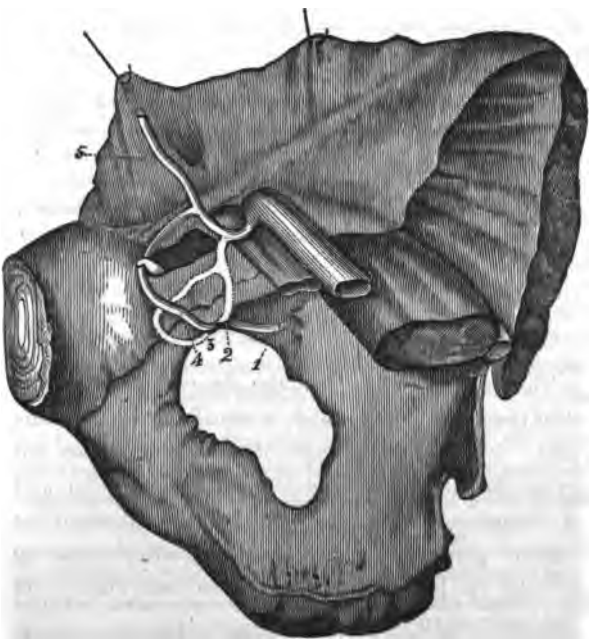
The *Anterior and larger Branch* descends between the adductor brevis and longus muscles, and supplies these as well as the obturator externus, adductor magnus, and gracilis muscles. It anastomoses with the internal circumflex and the muscular branches of the femoral artery. Some of its divisions extend into the perinæum, and anastomose with the pudic.

It also detaches a small vessel, which descends along the internal margin of the obturator foramen, to communicate with the posterior branch. In this manner a kind of arterial circle is formed around the obturator foramen.

The *Posterior Branch* descends along the outer edge of the obturator foramen, towards the tuberosity of the ischium, in passing between the internal and external obturator muscles. It supplies the adjacent muscles and the capsular ligament of the hip joint.

* When the obturator artery comes from the epigastric its vein and nerve lie below it.

It also sends a small branch through the notch in the acetabulum, to supply the Haversian bodies, round ligament, and head of the femur.




The obturator artery not unfrequently comes off from the epigastric; and the accompanying wood-cut (copied from my plates of Hernia), shows the different routes it may take, in either case, to arrive at the obturator foramen. First, it may arise (1) from the internal iliac, and accompany the obturator nerve. Secondly, it may arise (2) from the epigastric (marked 5), and descend without crossing the femoral ring, towards the obturator foramen. Thirdly, it may arise (3) from the epigastric, and cross along the transverse ramus of the pubes, to the inside of the femoral ring. Or, fourthly, it may arise (4) from the epigastric,

and get to the inside of the ring, by running along its anterior margin, *i. e.* along Poupart's ligament.

It is evident that it is only in this last case it will circumscribe a femoral hernia, and be endangered in the operation. This peculiarity in its course was first pointed out by *Mr. Wardrop.* In the Med. and Surg. Journal, for 1806, he relates two cases of this kind: one seen by himself and Dr. Barclay, in Edinburgh; and another by himself, in Paris.

The obturator artery may also arise from the external iliac, or from the femoral (*Monro, Burns, Otto, Tiedemann*), or by a double root from the internal iliac and obturator (*Portal* and *Hesselbach*). Green relates a case, in which it was wanting on one side, and its place supplied by branches of the profunda. The preparation is in Dr. M'Cartney's museum.

## The Pudic Artery.

This artery is larger than the obturator, but smaller than the sciatic, with which it usually arises in common. It descends in front of the sacral plexus and pyramidal muscle, between the rectum and outer wall of the pelvis, and escapes from this cavity through the inferior part of the sacro-sciatic notch, in passing between the lower edge of the pyramidalis muscle and the lesser sacro-sciatic ligament.

[*We cannot follow the artery further without dissecting the perinæum; a brief description of which will be found in the note.* But the student that is not dissecting may read on without interruption.*]

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* In order to prepare a subject for examination of the perineum, the hands should be brought down to grasp the outer edges of the feet, and retained there by a roller. The rectum is then to

After the pudic artery has escaped from the pelvis, it curves round the spine of the ischium, to re-enter

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be stuffed with tow, the knees held apart, a staff introduced into the bladder, and the scrotum thrown up on the abdomen.

*The Perineum* thus exposed, has the shape of a lozenge, or of two triangles joined at their bases. The anterior angle corresponds to the root of the scrotum, the posterior angle to the tip of the coccyx, and the lateral angles to the tuberosities of the ischia. On raising the integuments we bring into view *the great perineal fascia;* it is strong, coarse, and cellular, and of a yellowish colour. It is this membrane that prevents any appearance of external tumour, when the urine has been extravasated, as in consequence of rupture of the urethra. The fluid in this case cannot pass backwards, in consequence of some grisly fat that fills the cells; nor laterally on account of the adhesion of the fascia to the tuberosity of the ischium, for though this membrane appears to glide loosely over the tuberosity, when its cutaneous surface is rubbed, yet if we cut through it, and attempt to draw it from the bone, we find it firmly adhering. The consequence of this disposition is that the fluid passes forward into the scrotum (in which the penis seems buried), and may then extend on the abdomen, and even over Poupart's ligament to the thigh. Involved in the superficial fascia will be found the superficial sphincter muscle. It lies close to the integuments, and has an elliptical form. Its posterior angle is united to the tip of the coccyx, by *the recto-coccygeal ligament,* (which is, in fact, nothing more than a raphè formed by the levatores ani meeting on the middle line,) and its anterior angle terminates in *the tendinous point of the perineum,* which is situated immediately behind the bulb, and is a central point, in which terminate several muscles; viz. the superficial sphincter, the acceleratores urinæ, transversus perinei, and Wilson's muscles. We may now raise the superficial fascia, and we will come on another, which is thin, aponeurotic, blueish, and silky-looking: this is *the deep fascia.* We also observe the parts it covers; viz. the urethra, on the middle line, embraced by the acceleratores urinæ muscles; and on either side the crus penis, round which is spirally turned the erector penis muscle. An angle is therefore formed between the accelerator urinæ muscle and the erector penis, and this angle is

by the lesser sacro-sciatic notch, through which the obturator internus muscle goes out. It then ascends

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completed into a triangle by the transversus perinei, which passes forwards and inwards from the tuberosity of the ischium to the tendinous point of the perineum. On the cutaneous surface of the muscle we observe two branches of the pudic artery; one the transversus perinei, following the course of the muscle, and the other the inferior perineal, curving round it, to advance between the accelerator urinæ and erector penis muscles. If we press the finger into the interval between these two muscles we find it resisted by a strong membrane, viz. the triangular ligament, which fills the upper part of the sub-pubic angle. Its apex is in front of the sub-pubic ligament; its lateral margins are attached to the rami of the ischium and pubes, where they are continuous with the obturator fascia, — and its base has the form of a double arch, like the velum palati. In each of these arches, and in the substance of the ligament, runs the artery of the bulb, which having arrived on the middle line, sends one branch in front of the ligament to the bulb and another behind it to Cowper's gland. Through an opening in this ligament is transmitted the urethra; the part of it which pierces the ligament is the junction of the membranous portion with the spongy: consequently the spongy portion (which includes the bulb) is in front of the triangular ligament, and the membranous and prostatic portions are behind it. The opening for transmitting the urethra is, in an adult, about an inch below the symphysis pubis, and two inches from the tuberosity of the ischium, and about one fourth of an inch above the base of the ligament. Its orifice does not present a distinct margin, as there is a production from it both forward over the spongy portion, and another backward (funnel-shaped) over the membranous and prostatic portions. It is this latter production that is usually termed the posterior layer of the triangular ligament. It unites with the vesical fascia at the neck of the bladder. An American writer states that the part of it on the inferior surface of the prostatic gland is reflected on the front of the rectum, so as to form a cul de sac, opposed to that of the peritoneum. The division of the cul de sac in lithotomy he conceives to be attended with considerable risk of abscesses and peritonitis.

towards the symphysis pubis lying between the obturator muscle and fascia in a kind of groove, which is

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From the front of the triangular ligament arises *the accelerator urinæ muscle*, which may next be described. In front it takes an origin from the side of the corpus cavernosum; behind this it arises in common with that of the opposite side by an aponeurosis, which is interposed between the corpus spongiosum and corpus cavernosum, and posteriorly it arises from the front of the triangular ligament. The fibres of the first origin run downwards and backwards, to meet on the middle line; and as they approach each other they present on the inferior surface of the urethra the form of the letter V; the fibres of the second origin proceed directly downwards and those from the triangular ligament downwards and forwards; finally they are all inserted on the middle line in a raphè, which runs along the inferior surface of the urethra, and terminates posteriorly in the tendinous point of the perineum. *The erector penis* arises from the tuberosity of the ischium, and ascends on the crus penis, on the fibrous covering of which it is lost. The trunk of the pudic artery will be found on the inside of the ascending ramus of the ischium, about three inches from the surface, and covered by a production from the great sacro-sciatic ligament. The rest of this note may be omitted till the pelvic arteries have been dissected.

So far we have been considering only the anterior triangle or anterior region of the perineum; let us now direct our attention to the posterior region. Here we find a considerable quantity of adipose cellular tissue, embedded in a cavity termed *the ischio rectal*, the outlet of which is bounded externally by the ischium, internally by the rectum and levator ani, anteriorly by the transversus perinei muscle, and posteriorly by the margin of the glutæus maximus muscle, extending from the tip of the coccyx towards the tuberosity of the ischium. This aperture leads into a deep cavity of a pyramidal form, the apex being turned towards the pelvis. In front it has a pouch, above the transversus perinei muscle, and posteriorly another, much deeper, above the glutæus maximus. Each side is lined by a membrane, and both membranes are united superiorly. In order, however, to make this matter more clear, it will be necessary to trace all these layers of fascia

covered in inferiorly by a process of the great sacro-sciatic ligament that extends as far forward as the

from their source, viz. the pelvic or iliac fascia. The iliac fascia is attached to the crest of the ilium, and covers the psoas and iliacus muscle and anterior crural nerve. It then passes under the external iliac vessels, to descend into the inferior or true pelvis. From its anterior surface is detached (along the outer edge of the external iliac artery) a cellular membrane, *the fascia propria*, that covers the iliac vessels, and extends in every direction, as well into the pelvis as on the back of the abdomen. The iliac fascia having descended as far as the upper edge of the levator ani, divides into two layers, between which this muscle is placed; *one layer*, on the inside (*the vesical*), descends to the bottom of the pelvis, and then ascends on the neck of the bladder, where it unites with the posterior layer of the triangular ligament. This layer is confined to the anterior part of the neck of the bladder, and goes no farther back than the spine of the ischium; hence the bladder, when dilating performs a rotation, which throws the upper extremity of it forwards, on account of its being tied down anteriorly, while the posterior part is at liberty to dilate. *The other layer* of the iliac fascia descends between the obturator muscle and levator ani, and divides into the obturator fascia and the rectal fascia. Now these are the two fasciæ that line the ischio-rectal cavity; viz. *the obturator* on the outside, and *the rectal* on the inside. The former has its external surface applied to the obturator muscle and pudic artery, and its inferior edge is inserted into a production of the great sacro-sciatic ligament, while the latter, peculiarly thin, is applied to the levator ani and rectum. Nothing now remains but the description of

*The Lateral Operation for the Stone.* — The rectum having been previously emptied by an enema, and the patient desired to retain his urine, the hair of the perineum should be shaved, and the presence of the stone ascertained. A grooved staff is then to be introduced into the bladder, and the patient tied, as already desired, and laid on his back, on a table of convenient height. The scrotum being raised by an assistant, and the operator sitting on a low chair, or kneeling on one knee, before the patient, holds the staff vertically in his left hand, keeping it firmly drawn up and

crus penis: in this course it is separated from the ichium by the internal obturator muscle. It then

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and made prominent in front. The first incision commenced about half an inch below the symphysis pubis, and carried downwards and outwards on the left side of the perineum, until it has fairly passed the interval between the rectum and tuberosity of the ischium. This incision will divide the superficial fascia and superficial sphincter, and form a wide gaping wound. The second incision should commence about half an inch lower down, and being carried in the same direction will unavoidably divide the inferior perineal nerves and vessels, and passing between the accelerator urinæ muscle and erector penis, divides the central fibres of the levator ani; it should also be carried sufficiently far back, to cut across the tranversus perinei muscle. The staff is now to be lateralised so as to turn its convexity downwards and to the operator's right side. The point of the scalpel should now be passed under the base of the triangular ligament, avoiding the artery, and then carried over the bulb to the membranous part of urethra, in which the groved staff will be felt. As soon as the point of the knife has been made to enter the groove it should be shaken in it a little, in order to be certain that it is fairly lodged. In performing the last and most important incision, the edge of the knife should neither be turned outwards for fear of wounding the pudic artery, nor downwards lest the rectum be wounded — but in an intermediate direction. The point of the knife is now to be advanced steadily in the axis of the bladder, and according as it advances, the handle of the staff may be depressed to make room for it, making it rotate on the point of the knife, as on a pivot. In this manner, the membranous and prostatic portions of the urethra will be divided, and as the urethra in passing through the prostate gland, is nearer to its upper than to its lower surface, one third of the gland will be left above, and two thirds below. We know that the scalpel has advanced far enough when the resistance of the prostate ceases, and a gush of urine follows. The knife being withdrawn, the first and second fingers of the left hand are to be introduced, and on them the blunt gorget as a director. The staff is now to be withdrawn, and on the concavity of the gorget should be intro-

pierces the triangular ligament to terminate in the angle between the crura penis.

The trunk of the pudic artery, in some cases, instead of going out of the pelvis through the great sciatic notch, descends along the inferior surface of the bladder; then over the prostate gland, to be distributed to the penis.

Before the pudic artery quits the pelvis it gives a few small branches to the rectum, bladder, and to the vesiculæ seminales in the male, and to the upper part of the vagina in the female.

As it turns round the spine of the ischium, it supplies the rotator muscles; but its principal branches are given off after it has returned into the pelvis. They are as follows: —

1. The *External Hæmorrhoidal.* —These pierce the obturator fascia to reach the inferior part of the rectum. They communicate with the middle (p. 199.) and superior hæmorrhoidal arteries.

2. The *Perineal Artery* pierces the obturator fascia, then curves under (that is, superficial to) the transversus perinei muscle, and advances in company with the inferior perineal nerve in the triangular space be-

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duced the forceps, which at first is only to be used as a probe to feel for the stone. When this is ascertained, it is to be taken hold of by its short axis and withdrawn. If it be very large, it may be necessary to break it with Le Cat's forceps, and in this case great care will be necessary to wash out subsequently every remaining fragment. If after the operation we find the urine does not come through the wound but through the urethra, and stained with blood, we know that hæmorrhage has occurred, and we therefore at once remove the clots that obstruct the wound, and fill it with a sponge, through which a female catheter has been passed, for allowing the escape of the urine.

tween the erector penis and accelerator urinæ muscles; being nearer to the ischium than to the raphè or middle line of the perineum. In this course it supplies the two last-mentioned muscles and the sphincter ani and integuments, after which it penetrates the septum scroti, and forms a network of vessels, both in the septum and in the subcutaneous cellular tissue of the rest of the scrotum. It anastomoses with branches of the spermatic and external pudic arteries.

In the female this branch is larger in proportion to the other branches, and is the great artery of the labium.

*The transverse Artery of the Perineum* is a small branch, which passes inwards and forwards on the cutaneous surface of the transversalis perinei muscle. This small branch is always necessarily divided in the lateral operation for the stone.

The pudic artery also sends small branches to the internal obturator, erector penis, and transversus perinei muscles, and a very important branch, termed —

4. The *Artery of the Bulb.** — This artery passes inwards through the very substance of the triangular ligament, following its lunated margin, and terminates by dividing into two branches; viz. a smaller to Cowper's gland, and a larger to the bulb of the urethra.

The terminating branches of the pudic artery are —

5. The *Artery of the Corpus Cavernosum.* — This

* On account of the fibrous structure through which this artery passes, it cannot retract when divided. Hence the great danger of wounding it in lithotomy.

artery pierces the crus penis, and advances through the corpus cavernosum, distributing its branches on either side, and gradually approaching the middle line. It communicates through the septum with that of the opposite side, and ramifies in the areolar tissue of the corpus cavernosum.

For the following account of Müller's opinion as to the distribution of the arteries of the corpus cavernosum I am indebted to Dr. Baly's excellent translation.

"The arteries of the corpora cavernosa have two sets of branches. The one set are the ultimate ramuscules, which terminate in the minute radicles of the veins, and are designed for the nutrition of the part. The other set come off from the side of the arteries, and consist of short, slightly curled branches, terminating abruptly by a rounded, apparently closed, extremity, turned back somewhat on itself; these are sometimes single; sometimes several arise by one stem, forming a tuft. I have named them *arteriæ helicinæ*. They project into the venous cells, and are found principally in the posterior part of the corpora cavernosa, and of the corpus spongiosum urethræ. They are most distinct in man. Although no openings can be discovered in the coats of these free arterial excrescences, yet there is no doubt but that it is through them that the blood, which is ordinarily carried into the texture of the corpora cavernosa by the minute nutrient branches of the arteries, is in the act of erection poured directly into the venous cells and sinuses. When the arteria corporis cavernosi is injected with size and vermilion, the injected matter always fills the venous cells; and if it is afterwards washed from them, the arteriæ helicinæ will be seen injected. The means by which during life they are enabled to force blood into the cells, must be the increased attraction exerted between their coats and the blood by the nervous influence transmitted to them by the spinal cord, in consequence of which attraction an increased quantity of blood goes to them. This throws new light, at the same time, upon the mutual action of the blood and smaller vessels in other parts, and upon the phenomenon of active turgescence, or turgor vitalis. (Mueller's Archiv. 1834, p. 202. tab. xiii.) The blood is returned from the corpora cavernosa partly by small veins,

running at the sides and on the surface of these bodies into the vena dorsalis, partly by deeper veins which issue from the corpora cavernosa at their root, and enter immediately the venous plexus, situated behind the symphysis pubis. The fact, then, that the vena dorsalis does not return the blood from the deep veins, shows that no pressure on the former vein alone can cause accumulation of blood in the penis. (See the article *Erection*, by Mueller, in the Encyclop. Wörterbuch d. Medicin. Wissensch.)"

In the female, the terminating branches of the pudic artery are distributed in a similar manner; that is, one branch is on the dorsum of the clitoris, and the other terminates in its corpus cavernosum.

The *Dorsal Artery of the Penis* ascends between the crus penis and symphysis pubis, then advances in front of the sub-pubic ligament and through the substance of the suspensory ligament of the penis, to arrive in the longitudinal groove on the upper surface of the corpus cavernosum. As they advance in this groove they supply the integuments and fibrous layer of the corpus cavernosum. Having arrived as far as the glans penis, it communicates with that of the opposite side both above and below, so as to form a vascular ring, from which vessels are detached to the glans and the prepuce. The corresponding nerve accompanies the artery lying on its outside; and the dorsal vein, which is common to both arteries, is found on the middle line between them.

*Varieties.* — The dorsal artery of the penis sometimes comes directly from the iliac, and passes along the side of the prostate gland, to arrive at its destination. I have seen several cases of this kind; and the late Dr. M'Dowel remarked to me that this variety was more frequent on the left than on the right side.

Dr. Green has seen the dorsal artery arising from the obturator,

which was given off from the femoral a little below Poupart's ligament. Cruveilhier has seen the dorsal artery of the penis arise from the superficial or external pudic, near the aperture for the saphena vein; and, after forming a curvature in the groin, with its convexity turned downwards, proceed along the lateral surface of the penis. In another case, in addition to its usual root, which was diminutive, it had a second, of considerable size, which arose from the obturator artery, and passed under the symphysis pubis, to join the former.

We now come to the branches of the internal iliac that remain within the pelvis.

The *Ilio-lumbar Artery* arises from the posterior part of the internal iliac, and takes a direction upwards, backwards, and outwards in front of the lumbo-sacral nerve, which it separates from the obturator. It then passes behind the psoas muscle into the iliac fossa, and divides into its terminating branches; viz. the iliac and lumbar. The *iliac branch* takes a transverse direction beneath the anterior crural nerve and iliacus internus muscle. Some of its branches ramify on the surface of the muscle, and others deep-seatedly. From the latter arises the nutritious artery of the ilium, which enters the canal observable near the centre of the internal iliac fossa. The *lumbar branch* sometimes arises from the middle sacral. It ascends under cover of the psoas muscle. One of its branches enters the lateral foramen of the spine between the fifth lumbar vertebra and the sacrum, and is distributed on the tunics of the spinal marrow. The others are distributed to the psoas muscle and quadratus lumborum.

The communications of this artery are extremely

important. Its lumbar branch communicates with the proper lumbar and intercostal arteries, and its iliac branch communicates freely at the crest of the ilium with the glutæal, circumflexa ilii and external circumflex femoris arteries. This explains how blood is freely carried to the extremities when the iliac artery or lower part of the aorta has been rendered impervious.

*Varieties.* — The ilio-lumbar artery not unfrequently comes from the glutæal. Sometimes it is double, — its iliac and lumbar branches arising separately. Its size often seems to depend on the number of lumbar arteries; the ilio-lumbar being small whenever there happens to be a fifth lumbar artery.

The *Vesical Artery* arises from the lowest part of the internal iliac, immediately before it contributes to form the superior vesical ligament. It accompanies the ureter to the inferior region of the bladder, and its branches are distributed to this reservoir and to the prostatic gland, vesiculæ seminales, and urethra. One of its branches, the *deferential artery*, has been particularly described by *Sir A. Cooper*, in his recent work on the testes. It accompanies the vas deferens in its entire route, supplying in the first part of its course the vesiculæ seminales, and at its termination the testis and epidydimis.

Other arteries to the bladder are given off by the pudic, obturator and middle hæmorrhoidal. There are also branches given off by the umbilical artery; but they are only pervious in a part of their course.

The *Middle Hæmorrhoidal Artery* descends obliquely upon the anterior and lateral part of the rectum, which it supplies. It communicates superiorly with the hæ-

morrhoidal branches of the inferior mesenteric artery, and inferiorly with those of the pudic.

*Varieties.* — This artery sometimes comes from the pudic before it leaves the pelvis, sometimes from the sciatic artery, and occasionally it is wanting.

The *Uterine Artery* proceeds to the superior and lateral part of the vagina and beneath the bladder. Having supplied these, it ascends on the side of the uterus, between the folds of its broad ligament. Here it divides into several branches, which penetrate its tissue and spread in a tortuous manner on both its surfaces, to communicate with that of the oppostie side. Some of them ascend to the round ligament and Fallopian tubes and anastomose with the spermatic arteries, and one or more of them descend on the vagina. These arteries are remarkable for the great tortuosity of all their branches, even the smallest; and this character they preserve even when they become greatly enlarged, as in pregnancy.

The uterine artery sometimes arises from the internal pudic.

The *Vaginal Artery* is equal in size to the uterine in the young subject, but smaller than it after puberty. It descends on the side of the vagina, to which it distributes several branches. It also sends a branch to the bladder, and supplies the external organs of generation.

*Varieties.* — This artery may be wanting, or it may come from the uterine, pudic, middle hæmorrhoidal, or even from the obturator.

The *Lateral Sacral Artery* descends obliquely inwards on the front of the sacral plexus, being sepa-

rated from the middle sacral by the trunk of the sympathetic nerve, and covered in front by the pelvic viscera. The external branches, usually four in number, enter the sacral foramina and supply the spinal membrane; they anastomose with the proper spinal arteries and, by branches that pass through the posterior sacral foramina, communicate with the coccygeal branch of the sciatic artery. The internal branches are distributed to the pelvic viscera, and anastomose with the middle sacral, and with those of the opposite side. The inferior or terminating branch communicates in the form of an arch with the corresponding division of the middle sacral artery.

*Varieties.*—The lateral sacral artery sometimes arises from the ilio-lumbar, and frequently from the glutæal. Occasionally, instead of forming an arch inferiorly, it terminates by entering the last sacral foramen.

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## The external Iliac Artery

Arises opposite the superior extremity of the sacro-iliac symphysis, and descends obliquely forwards and outwards towards the centre of Poupart's ligament. *Posteriorly*, it corresponds to the external iliac vein, which separates its origin from that of the internal iliac, the vein lying in the angle between the two arteries; farther on it lies on the psoas muscle and iliac fascia. *Anteriorly*, it is covered near Poupart's ligament by the circumflexa ilii vein, which sometimes however passes behind it, and by the peritoneum, and the fascia propria. *Externally* some fibres of the psoas muscle

separate it from the anterior crural nerve, which lies behind the iliac fascia, deeply embedded between the psoas and iliacus muscles. *Internally* it corresponds to the fascia propria, which descends to be lost in the true pelvis; and near Poupart's ligament, its vein is internal to it. A branch of the genito-crural nerve is also found in this situation, and in the male subject the vas deferens as it descends into the pelvis. From this account it follows that the anterior crural nerve is external to it and on a deeper plane; and that its corresponding vein is first somewhat posterior, and afterwards internal to it.

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MR. ABERNETHY'S OPERATION ON THE EXTERNAL ILIAC ARTERY.

The external iliac artery was first tied by Mr. Abernethy, in the year 1796, in a case of femoral aneurism. He had previously tied the femoral artery, according to Brasdor's plan, on the capillary side of the aneurism: but dangerous hæmorrhage having occurred on the fifteenth day after the operation, he proceeded to tie the external iliac artery. Having separately divided the integuments and aponeurosis of the external oblique muscle, for about three inches in extent; and over the course of the artery he next passed his finger beneath the margin of the internal oblique and transversalis muscle, and on it divided them in the same direction. The peritoneum being next pushed upwards and inwards, he proceeded to separate the vein from the artery. In this, however, much difficulty was experienced until a fascia* which covered and united them was divided; this was done with much caution, and a ligature passed round the artery from within outwards. In his next case he proceeded in a similar way, except that he made his incision not over, but in a line a little external to the course of the artery in order to avoid the epigastric. In both these cases he

* This was the fascia subsequently described by Sir A. Cooper under the name of the fascia propria.

failed; but in the third, in 1806, the patient perfectly recovered. Mr. Freer of Birmingham performed the operation in 1806; Mr. Tomlinson operated in 1807, and in a second instance in 1809 — in both cases with success. In 1814 Sir A. Cooper had performed this operation seven times, and four out of the seven cases were successful.

Mr. Hodgson describes in the following words:—

## Sir A. Cooper's Operation on the External Iliac Artery.

"A semilunar incision is made through the integuments in the direction of the fibres of the aponeurosis of the external oblique muscle. One extremity of this incision will be situated near the spine of the ilium; the other will terminate a little above the inner margin of the abdominal ring. The aponeurosis of the external oblique muscle will be exposed, and is to be divided throughout the extent, and in the direction of the external wound. The flap which is thus formed being raised, the spermatic cord will be seen passing under the margin of the internal oblique and transverse muscles. The opening in the fascia, which lines the transverse muscle through which the spermatic cord passes, is situated in the mid-space between the anterior superior spine of the ilium, and the symphysis pubis. The epigastric artery runs precisely along the inner margin of this opening, beneath which the external iliac artery is situated. If the finger, therefore, be passed under the spermatic cord, through this opening in the fascia, it will come into immediate contact with the artery, which lies on the outside of the external iliac vein. The artery and vein are con-

nected by dense cellular tissue, which must be separated, to allow of the ligature being passed round the former."

In Mr. Abernethy's way of operating, two thirds of the longitudinal incision are made over a portion of peritoneum, which closely lines the abdominal muscles, and does not require to be separated. It is therefore uselessly endangered. Moreover, the division of the muscles in this direction weakens the abdominal parietes, and gives a tendency to the formation of hernia, as occurred in the case of a patient operated on by Mr. Kirby. For these reasons A. Cooper's operation is generally preferred. It has been said that Mr. Abernethy's mode gives greater facility of tying the artery high up if necessary; but this can be equally well effected by enlarging the external angle of the incision, recommended by Sir A. Cooper.

The only remaining suggestions I have to offer are these: first, to be careful of the peritoneum, and not wound it if possible; I say if possible, because a case occurred in Dr. Post's practice in which this membrane was so thickened by disease that he could not detach it, but was obliged to make an opening in it and include a part of it in the ligature. Secondly, attend to the origin and course of the epigastric artery. Dupuytren lost a patient by wounding it, and Beclard by tying the iliac immediately beneath it, so that sufficient room was not left for the formation of a coagulum. In some cases (see *Varieties*), this vessel rises six or eight lines higher up than usual, and the operator should therefore search for its origin, and apply the ligature *above it*. Thirdly, the proximity of the vas deferens and the femoral branch of the genito-crural nerve are to be borne in mind.

When the trunk of the external iliac artery is tied, the limb is abundantly supplied by the internal iliac, through the following channels: — 1. The glutæal branch of the internal iliac transmits blood to the femoral artery, through the internal and external circumflex branches of the latter. 2. The sciatic artery transmits blood to the femoral by the internal circumflex and perforating arteries.* 3. The obturator artery supplies the femoral through

* Boyer dissected a patient who had been operated on by Dessault eight months previously for popliteal aneurism, and found

the branches that communicate with the internal circumflex. (See Med. Chirurg. Trans. vol. iv. Guy's Hospital Reports, No. 1. Jan. 1836.) Lastly, the pudic artery supplies the femoral by its communication with the pudic branches of the latter.

Upon examining the limb that has been thus operated on, we find that the portion of the femoral artery below the origin of the profunda is unchanged in calibre; while the portion, if any, between the origin of the profunda and the ligature may either remain the natural size, as in Mr. Norman's case *, or contracted, as in Sir A. Cooper's case †, in which the vessel, in this situation, was found reduced to half of its size. The operation of tying the external iliac artery has been several times performed; and Mr. Wilmot has justly observed, that it has succeeded in a greater proportion of cases, than operations on the femoral artery.

The branches of the external iliac artery are two in number, viz., the epigastric, and circumflexa ilii.

### *The Epigastric Artery*

Usually arises from the external iliac, about three or four lines above Poupart's ligament (see fig. in p. 187). From this origin it takes a direction forwards, inwards, and slightly downwards, across the external iliac vein. It next turns upwards and inwards, so as to form a curvature, the convexity of which turns downwards, looks towards Poupart's ligament, and, in some cases, even sinks into the femoral ring; the concavity looks upwards, and lodges a cul de sac of the peritoneum. We next trace the artery ascending obliquely inwards, between the fascia transversalis in front and

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the comes nervi ischiatici as large as the radial at the wrist. (See also Med. Chirurg. Trans. vol. xx.)

* Med. Chirurg. Trans. vol. xx.

† Guy's Hospital Reports.

the peritoneum posteriorly, to arrive at the inner margin of the internal abdominal ring. In this situation, the vas deferens hooks round it, having first passed upwards and outwards, to the ring in front of the artery; and then downwards and inwards, to the pelvis behind it. From the inguinal ring, the epigastric artery continues to ascend obliquely inwards, till it gets between the posterior surface of the rectus muscle and its sheath: finally it terminates in anastomosing with the internal mammary artery.

Its branches are, 1st, A *spermatic branch*, which descends with the spermatic cord, to be lost on the coverings of the testicle. 2dly, A branch which crosses behind the symphysis pubis, to anastomose with a similar branch from the opposite side. 3dly, An obturator branch, which descends behind the transverse ramus of the pubes, to anastomose with the obturator artery. 4thly, It gives several branches to the oblique muscles of the abdomen, some of which are of considerable size, and fatal hæmorrhage has been known to arise from a wound of one of them, in tapping the abdomen. Lastly, the epigastric artery terminates in anastomosis with the internal mammary in the substance of the rectus muscle.

*Epigastric Veins.*—The epigastric vein arises from the external iliac, close to Poupart's ligament, and ascends on the inside of the epigastric artery; it then bifurcates, and the artery lies between its divisions.

The epigastric artery may be anomalous, in arising higher than usual; or in arising in common with the obturator, or from the profunda femoris.

### *The Circumflexa Ilii Artery,*

Smaller than the preceding, usually arises a little beneath it, and sometimes opposite it. It then takes a direction upwards, backwards, and outwards, corresponding, not to Poupart's ligament, as usually represented, but to a white line marking the junction of the transversalis fascia with the fascia of the iliacus muscle. This raphè is a little above and behind Poupart's ligament. Having arrived near the anterior superior spine of the ilium, it terminates in dividing into two branches, one of which supplies the broad muscles of the abdomen, and anastomoses with the inferior intercostal and lumbar arteries; the other continues in the direction of the trunk, and, having arrived at the anterior superior spine of the ilium, terminates in anastomosing with the superficial circumflexa ilii, the external circumflexa femoris, the glutæal, and ilio-lumbar arteries.

*The Circumflexa Ilii Vein* comes from the external iliac, and usually crosses in front of, sometimes behind, the external iliac artery, to arrive at its destination.

*Varieties.*—The circumflexa ilii is sometimes double. It may arise from the femoral, or from the epigastric.

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### The Femoral Artery

Commences opposite Poupart's ligament, and terminates on passing through a tendinous opening in the adductor magnus muscle. Its course is nearly parallel to a line drawn from a point a little internal

to the centre of Poupart's ligament to the internal margin of the patella. It is at first on a plane anterior to the femur, but soon becomes internal, and lastly posterior. Its posterior surface is applied first to the psoas muscle; it then descends in front of the pectineus muscle, but separated from it by the profunda artery and the profunda and femoral vein. Between the pectineus muscle and adductor longus there is *sometimes* an interval in which the femoral artery corresponds to the adductor brevis: in the remainder of its course it lies on the adductor longus. In the superior third of the thigh it is covered only by integuments, two layers of fascia, and its sheath*; lower down by the sartorius muscle, with the interposition of a strong aponeurosis. This aponeurosis commences in a gradual manner, immediately below Scarpa's angle, and terminates abruptly opposite the origin of the anastomotic artery. Its fibres are distinct, and run obliquely downwards and outwards. The *Lateral Boundaries* of the femoral artery in the superior third of the thigh, are the sartorius muscle to the outside, and the adductors to the inside; the convergence of these below form Scarpa's angle. The surface on which it rests in this angle is not plane, but depressed along the centre line or axis—like a

* By the sheath is meant a production of the fascia transversalis, which descends behind Poupart's ligament, covering the front and lateral parts of the vessels; the back of the sheath is formed by the pectineal fascia. The artery is separated from the vein by a septum derived from the sheath, which has a funnel shape, and closes on the vessels inferiorly.

double shed roof inverted. The *Lateral Boundaries* in the middle third of the thigh, are the vastus internus to the outside, the adductor longus to the inside: these two muscles, with the sartorius and aponeurosis in front, form Hunter's prismatic canal. The *Femoral Vein* is at first placed on the inside of the artery, and in a plane slightly posterior. Opposite Poupart's ligament, it lies on the junction of the psoas and pectineus muscles; but on arriving at the origin of the profunda, it begins to get behind its artery, and so remains, projecting a little to its outside inferiorly. The *Anterior Crural Nerve*, opposite Poupart's ligament, lies in the depression between the psoas and iliac muscles, separated from the artery by a few fibres of the psoas muscle, and by the iliac fascia which covers the nerve, but is behind the artery. Three branches of this nerve are related to the artery in its course down the thigh. One of them accompanies the sartorius muscle, and is lost at the inside of the knee joint. The second is the saphenous nerve; it also crosses the front of the artery from without inwards as it descends in the thigh; it then accompanies the anastomotic artery, and lastly the saphenous vein. The third descends on the outside of the artery, and drops near the middle of the thigh into the vastus internus muscle.

*Anomalies.* — The femoral artery is sometimes double. Gooch has cited three instances; Velpeau mentions a fourth, and refers to Casamayor, who saw a fifth. In Velpeau's case the supernumerary artery gave off the branches usually given off by the profunda; and its peculiarity seems to consist in its having afterwards preserved sufficient size to descend below the knee. Sir

C. Bell found the femoral artery dividing into two equal trunks, which afterwards united to form the popliteal; and Mr. Houston has described a similar instance.

Another variety is the high bifurcation. Sandifort relates a case in which the femoral artery divided a little below Poupart's ligament into two vessels, the continuations of which were the posterior tibial and peroneal; and Portal refers to a case in which it divided high up in the femoral region into two vessels, the continuation of which formed two popliteal arteries.

*General Observations.*

The usual circumstances requiring ligature of the femoral artery, are wounds of that vessel, or aneurism in the popliteal region. Mr. Hunter was the first that tied the *femoral* artery for popliteal aneurism. This operation was performed in the year 1785. His first incision was made through the integuments of the anterior and inner part of the thigh, a little below its middle, so as to cross somewhat obliquely the internal margin of the sartorius muscle. This being turned outwards, the fascia covering the artery was exposed and divided, so as to bring the femoral vessels into view. The artery having been disengaged from its connection, a double ligature was passed under it, and then divided, so as to make two ligatures; still lower down in the wound, two additional ligatures were applied, making four in all. This was done with a view to secure adhesion, by compressing a larger extent of the vessel. On the fifteenth day some of the ligatures came away. Soon after the patient left the hospital with some open abscesses, and six months after more of the ligatures came away, and the patient perfectly recovered. In an earlier part of the same year Dessault had tied the popliteal artery for popliteal aneurism; but Hunter's merit consisted in having tied the artery at a distance from the diseased part. It is scarcely necessary to inform the advanced student that the number of ligatures employed by Mr. Hunter, and the extent of the artery detached from its connections, were calculated to produce most dangerous consequences, such as abscesses and secondary hæmorrhage. In his second operation he committed another error in dressing the wound from the bottom; but it is proper to add that he gradually corrected these errors, and in his subsequent practice used only a single ligature, and endeavoured to unite the wound as quickly as possible.

*Ligature of the Femoral Artery in the Middle of the Thigh.*

In this situation the artery is covered by the sartorious muscle, and much discussion has arisen whether it be preferable to cut down on its internal margin and evert it, or on its outer margin, and then draw it inwards.* Both modes have their advocates. Mr. Hunter, whose operation I have already described, adopted the former plan; and the advocates for it affirm that it can be easier done, and that a depending opening is then gained for the exit of matter. On the other hand, Mr. Hutchinson, who has written a letter to recommend the latter plan, objects to the internal incision, that the artery is not easily found in this way, and that the saphena vein and trunks of the lymphatics are greatly endangered. The truth is, that if we operate on the very termination of the femoral artery, as Hunter did, we will find it easier to expose this vessel by cutting on the outer edge of the muscle. But if we operate a little below Scarpa's angle, which I believe to be a simpler and better operation, we must of necessity cut on the internal edge of the sartorious, unless we choose to have a tedious and difficult operation and a valvular opening. By not attending to this distinction, many useless discussions have arisen. In this country surgeons usually operate in Scarpa's angle; but in France, we are informed by Velpeau, that the operation in the middle third of the thigh is usually preferred.

If the artery be tied just before it pierces the tendon of the adductor magnus muscle (an operation which I do not recommend), the principal suggestions I have to offer are these: — 1. In order to avoid the saphena vein, and come more readily on the artery, I would advise the incision to be over the *external* or anterior margin of the sartorius. If care be not taken to divide the strong fascia that lies beneath this muscle, it will be impossible to find the artery. 2. The operator must be sure not to mistake the anastomotic for the femoral artery. This error has been committed. Lastly, he should remember how closely the artery and vein are connected in this situation; and, as the vein projects a little to

* Dessault proposes cutting this muscle across, which can never be necessary, though we are informed it produces no permanent injury.

the outside of the artery, the needle should be passed from without inwards, taking care not to include the saphenous or genicular nerve.

If the artery be tied higher up in the middle third of the thigh, our incision should be made over the internal margin of the sartorius muscle, the fascia, which is much weaker in this situation, divided, and the artery exposed. The nerves are to be avoided, and the needle passed from within outwards.

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## Ligature of the Femoral Artery in Scarpa's Angle.

The patient is to be placed on his back, on a table, and the thigh rotated slightly outwards, so as to make the site of the operation look directly upwards. The line of the artery is to be distinguished by feeling its pulsation, which will become indistinct or imperceptible, inferiorly, where the sartorius begins to overlap it. In the course of this line the first incision is to be made, through the integuments, commencing about two inches beneath Poupart's ligament, and extending from about two inches and a half to three inches. This incision will lie on the outside of the saphena vein. The superficial fascia should next be cautiously divided. Any lymphatic gland, or large cutaneous veins that present themselves, should be carefully avoided. A portion of the fascia lata should then be raised in the forceps, and divided horizontally; after which a director should be introduced into the opening in the fascia, with the view of enlarging it to the extent of an inch. The sheath of the vessel is now to be divided in the same cautious way, when the artery will be brought into view. The femoral vein lies

immediately behind the artery; and therefore a blunt instrument, such as an eye-probe, must be employed, with great caution, to separate them. The needle is then to be passed round the artery, from within, outwards, keeping it close to the artery, in order to avoid the vein and branches of the crural nerve, which usually lie to its outside. In some cases a nerve will lie directly over the artery. In this case I would endeavour to draw it outwards; but if this cannot be effected, I would have no hesitation in raising it with the forceps, and dividing it, as I have seen done with advantage. Should the femoral vein be unfortunately wounded, you will probably have no notice of it till the needle is being withdrawn, and then a gush of black blood will announce the accident. This is certainly an alarming occurrence; but I have known it to happen, and the patient to recover, without suffering any inconvenience whatever from it.

*State of the Circulation and Vessels after the Operation.*

1st. When the femoral artery is tied above the origin of the profunda, the circulation in the limb is carried on in the same manner as if the external iliac were tied. It will therefore be unnecessary to repeat my observation on the latter artery (see p. 204.) This operation has been performed for hæmorrhage after amputation.

2dly. When the femoral artery is tied beneath the origin of the profunda, we find the circulation maintained by the latter vessel, the circumflex branches of which freely anastomose with the anastomatic and inferior muscular branches of the femoral, and with the articular branches of the popliteal. If this operation has been performed for popliteal aneurism, the femoral artery afterwards becomes impervious as far up as the origin of the profunda*; and

* In some of the cases, however, in which the artery has been tied low down, the impervious state may not extend to the

the portion of it between the ligature and aneurismal tumour may either be obliterated throughout (see Sir A. Cooper's case, in Med. Chirurg. Trans. vol. i.), or pervious throughout (see Hodgson, on the Arteries; also the late Mr. Todd's case, related by Mr. Alcock, in Todd's Cyclopædia, art. *Femoral Artery*); or partly pervious, being interrupted at different parts of its course by points of obliteration. If the femoral artery be tied below the profunda, independently of aneurism, the obliteration on either side of the ligature will extend to the next considerable branch.

The branches of the femoral artery are the superficial epigastric, the superficial pudic, the superficial circumflexa ilii, the profunda, and the anastomotic.

*The Superficial Epigastric Artery* arises a little below Poupart's ligament, pierces the fascia lata, and ascends towards the umbilicus in front of Poupart's ligament. It supplies the glands of the thigh, and the fascia and integuments of the abdomen, and anastomoses with the internal epigastric and mammary arteries.

*The Superficial Pudic Arteries* are two in number; the superior comes off a little below Poupart's ligament, crosses *before* the fascia to reach the scrotum in the male — or labium in the female, in which, and the abdominal muscles, it is lost; the inferior pudic branch crosses *behind* the fascia, and supplies the scrotum in males, and the labia in females, and terminates in the perineum. These anastomose with each other, and the superior anastomoses with the superficial epigastric.

*The Superficial Circumflexa Ilii*, smaller than the preceding, follows the course of Poupart's ligament beneath the integuments, and at the anterior superior

origin of the profunda, but only to the origin of the muscular branches.

spine, terminates in anastomosing with the deep circumflexa ilii, the ilio-lumbar, glutæal and external circumflex femoris arteries.

The profunda is the next branch given off; but it will be more convenient to examine the anastomotic artery first.

*The Anastomotic Artery* comes off immediately before the femoral artery pierces the tendon of the adductor magnus muscle. It then divides into three branches; one of these crosses transversely outwards through the fibres of the vastus internus muscle; another runs downwards and outwards in the course of the fibres of the same muscle; and a third descends with the saphenous nerve to the inside of the knee joint, where it is distributed. These three branches sometimes come off separately from the femoral.

### *The Profunda Femoris*

Arises from the posterior and external part of the femoral, at about an inch and a half to two inches below Poupart's ligament; in some rare cases it arises much lower. It proceeds at first obliquely, downwards and outwards, over the tendon of the psoas and the upper extremity of the cruræus muscle. It then turns inwards over the vastus internus muscle, and descends between the adductor longus and magnus, to terminate by a small branch, which perforates the latter muscle, supplies the hamstring muscles, and inosculates with the perforating arteries.

*Varieties.*—The profunda artery sometimes arises within the pelvis, from the external iliac; this is its regular origin in birds.

In the case in which Mr. James tied the aorta, the profunda arose above Poupart's ligament, and gave off the epigastric.

The branches of the profunda artery are the external circumflex, internal circumflex, and the perforating.

*The external Circumflex Artery* arises from the external side of the profunda, where the latter is forming its curvature to descend inwards. From this origin it runs almost transversely outwards behind the sartorius and rectus muscles, and through the midst of the fasciculus of branches descending from the anterior crural nerve. It terminates in three branches: viz. an ascending, transverse, and descending. — 1st. *The ascending branch*, considerably the smallest, runs upwards and outwards behind the tensor vaginæ femoris, in the interval between the iliacus internus and glutæus medius muscles, till it reaches the anterior superior spine of the ilium, where it terminates in anastomosing with the superficial and deep circumflexa ilii arteries, and with the glutæal and ilio-lumbar. — 2d. *The transverse branch*, larger than the preceding, runs outwards, in front of the superior extremity of the shaft of the femur, and then curves round to its posterior surface. In this course it passes through the superior fibres of the vastus externus, and then pierces the insertion of the glutæus maximus. On raising the latter muscle the termination of this branch is seen; it supplies the adductor muscles, the vastus externus, and the capsule of the hip joint. — 3d. *The descending branch* (or rather set of branches, as there are usually two and frequently more), is much the largest; it runs downwards and outwards, first

between the rectus muscle and cruræus, and then between the vastus externus and cruræus. It sends many branches to these muscles, and terminates near the patella in inosculation with the anastomotic and external articular arteries. When there is but one descending branch it goes to the vastus externus.

*Varieties.*— The external circumflex artery may arise after the internal circumflex, or in common with it; or it may arise from the femoral, or be large enough to seem a bifurcation of the profunda.

*The internal Circumflex Artery*, usually larger than the external, arises from the posterior and internal part of the profunda. It first sinks from before backwards, between the pectineus and the tendon of the psoas and iliacus; next between the obturator externus muscle and superior edge of the adductor brevis; and lastly, between the quadratus femoris and adductor magnus. In this course it winds round the inside of the neck of the femur, and its termination may be seen by raising the glutæus maximus. The branches may be classed into the internal, external, and ascending. *The internal branches* are distributed to the adductor muscles, and sometimes supply the place of the superficial pudic arteries. *The external branch* * is small; it passes through the notch in the internal margin of the acetabulum and beneath the transverse ligament; it is then conducted by the

* In complete fracture of the neck of the femur, within the capsular ligament, this and a similar branch of the obturator is the only source from which the head of the bone can receive blood; and this is one of the reasons assigned by Sir A. Cooper why osseous union does not occur in those cases.

ligamentum teres to the head of the femur, which it supplies. *The ascending branches* supply the pectineus and origin of the adductor longus. On dividing the pectineus, we find them freely inosculating with the branches of the obturator artery; and still deeper there is a trochanteric branch, which ascends in front of the quadratus femoris, to arrive at the digital fossa of the great trochanter. It supplies the muscles inserted in this situation, and inosculates with the sciatic, glutæal, and external circumflex arteries. On turning the subject, and raising the glutæus maximus muscles, we see the termination of the internal circumflex artery, running inwards along the lower margin of the quadratus femoris muscle. It supplies the origins of the hamstring muscles, the adductor magnus, and the sciatic nerve, and anastomoses with the sciatic and glutæal arteries.

*Varieties.* — This vessel sometimes comes off before the external circumflex, sometimes directly from the femoral (*Harrison and Burns*), sometimes from the external iliac (*Burns*), or, lastly, it may arise by a common trunk with the external circumflex (*Green*).

On one occasion M. Roux cut down on this vessel, and tied it; but such an operation will be seldom necessary.

3dly. *The perforating Arteries* are three in number: the termination of the profunda is often described as a fourth. *The first* arises a little below the lesser trochanter; it passes backwards beneath the lower edge of the pectineus muscle, and pierces the aponeurosis of the adductor brevis and magnus muscles. It then divides into two principal branches, one of which ascends in the substance of the glutæus maximus,

while the other descends in the long head of the biceps, and also supplies the vastus externus, semi-membranosus, and semitendinosus muscles. This artery anastomoses with the glutæal, sciatic, circumflex, and inferior perforating arteries. *The second* is the largest of the perforating arteries. It arises a little below the preceding, and pierces the aponeurosis of the little and great adductor (sometimes of the great adductor only); it then divides into several branches that supply the glutæal and hamstring muscles, and communicate with the other perforating arteries. It also gives off the nutritious artery of the femur. *The third* is the smallest of the three; it pierces the aponeurosis of the adductor magnus, and its branches are distributed in the same manner as the two other.

After the femoral artery has given off its anastomotic branch, it descends obliquely backwards through a slit or opening between the adductor magnus muscle and bone, and having arrived in the popliteal space, becomes the popliteal artery. This opening is bounded on the outside by the vastus internus; on the inside by the adductor magnus; inferiorly by the insertion of the tendon of this last muscle into the internal condyle, and superiorly by the adductor longus. Its circumference is entirely tendinous, in order to provide against the transmitted artery and vein being obstructed during the contraction of the muscles.

## The Popliteal Space

Is the name given to the hollow in the posterior region of the knee joint. It occupies about the inferior third of the thigh and superior fifth of the leg. In raising the integuments, we bring into view the termination of the *posterior cutaneous Nerve*, which is a branch of the sacral plexus. We may next examine the fascia, the fibres of which run transversely in the upper part of the popliteal space, and obliquely in its lower part. This fascia is of considerable strength, and attached to the hamstring muscles on either side, forming special sheaths for each. In this stage of the dissection, the posterior saphenous nerve, vein, and artery, may be seen advancing to the surface and descending between the heads of the gastro-gnemius muscle.

The popliteal space has the form of two triangles, the bases of which are united opposite a transverse line crossing the condyles of the femur. The superior triangle is bounded by the hamstring muscles; viz., on the outside by the tendon of biceps, and on the inside by the semimembranosus muscle and the tendons of the sartorius, gracilis, and semitendinosus. The inferior triangle is bounded by the inner and outer head of the gastro-gnemius muscle, both of which are situated between the inner and outer hamstring muscles. The fibular division of the great sciatic nerve descends obliquely outwards between the tendon of the biceps muscle and outer head of the gastro-gnemius; and the slender tendon of the semitendinosus muscle may be observed descending

between the inner head of the gastrognemius and the fibres of the semimembranosus muscle. It may be observed, that the outer boundary or biceps muscle is tied down to the femur by the origin of its short head; while the hamstring muscles on the inside have no such attachment; and therefore the popliteal space is more open in this direction. The popliteal nerve descends along the external margin of the semimembranosus muscle, but the vein and artery are overlapped by it.

### The Popliteal Artery

Extends from its entrance into the popliteal space to the lower margin of the popliteus muscle. Situate at first behind the internal condyle of the femur, it runs obliquely downwards and outwards, and terminates inferiorly on the middle line of the limb. Its anterior surface corresponds superiorly to the femur; lower down to the posterior ligament of Winslowe, from which one or two lymphatic glands separate it; and still lower to the fibres of the popliteus muscle. Its posterior surface is covered superiorly by the semimembranosus muscle; in the middle of its course by its own vein, the skin and fascia, a quantity of cellular tissue and the popliteal nerve; and inferiorly by the popliteal fascia and internal head of the gastro-gnemius muscle. Its vein adheres firmly to its posterior surface, projecting a little to its external side above, but to its internal side inferiorly. The popliteal nerve is much more superficial, and some adipose tissue is interposed between it and the vessels. In the supe-

rior part of this space it is found at the external margin of the semimembranosus muscle, and therefore external to the artery, while inferiorly, on account of *the oblique direction of the artery*, the nerve is on a plane internal to it. The branches of the popliteal artery (omitting the numerous branches to the muscles and adjacent cellular tissue), are the five following: —

*The superior internal Articular Artery* arises under cover of the semimembranosus muscle; it runs upwards and forwards over the internal condyle of the femur, between that bone and tendon of the adductor magnus; it terminates in two branches, one of which supplies the vastus internus, and the other is lost on the side of the knee joint: it anastomoses with the inferior internal articular artery, and with the anastomotic.

*The superior external Articular Artery* passes upwards and outwards over the external condyle of the femur, between that bone and the biceps tendon. It terminates in two branches, one of which supplies the vastus externus muscle, while the other is lost on the side of the joint. It communicates with the anastomotic, with the external circumflexa femoris, and with the inferior external articular artery.

*The inferior internal Articular Artery*, larger than the external, runs downwards and inwards, along the superior margin of the popliteus muscle, then winds bound the inside of the neck of the tibia, covered by a production of the internal lateral ligament, and by the tendons of the sartorius, gracilis and semitendinosus muscles. It is lost on the side of the joint.

*The inferior external Articular Artery* comes off a

little lower down than the preceding. It crosses outwards beneath the external head of the gastro-gnemius muscle, and then turns forwards between the external lateral ligament and convex margin of the external semilunar cartilage. Finally it terminates in two branches, one of which ascends along the external margin of the patella, and anastomoses with the superior articular artery; the other descends and divides into two branches, one of which sinks behind the ligamentum patellæ, and is lost in the fat in this situation; the other anastomoses with the tibial recurrent.

The French writers describe *two* superior internal articular arteries; but one of them is that which I have described as the anastomotic branch of the femoral. In addition to the articular branches, the popliteal artery gives off several muscular branches, and a small vessel that accompanies the posterior saphena vein.

*The middle articular* or azygos branch arises from the front of the popliteal artery, runs downwards and forwards, and pierces the posterior ligament of Winslowe, to supply the crucial ligament and condyles of the femur. It is considerably smaller than either of the preceding arteries.

*Ligature of the Popliteal Artery.* — In its superior third, it may be exposed by an incision on the external margin of the semimembranosus muscle, closely applied to which is the popliteal nerve. The muscle being drawn inwards, and the nerve outwards, the vein is closely applied to the posterior or cutaneous surface of the artery, and projecting a little to its out-

side. Great caution is therefore necessary in separating the vessels, and the needle should be passed from without inwards.

The popliteal artery may be secured in its inferior third, by a vertical incision between the heads of the gastro-gnemius muscle. The posterior saphenous nerve and vein being drawn out of the way, the popliteal nerve will be brought into view: deeper and more external is the vein, and still deeper and projecting on the outside of the vein is the artery. The nerve may be drawn to the inside, and the vein either internally or externally, as may be found most convenient. The needle is to be introduced with its convexity to the vein.

It is not advisable to apply a ligature on the popliteal artery in the middle of its course, on account of its depth, the unyielding nature of its lateral boundaries, and its vein and nerve lying so directly over it.

*Varieties.* — The principal varieties of the popliteal artery are included in those of the femoral (which see page 209.). We have only to add in this place, that the popliteal artery sometimes divides at one point into three branches; viz., the anterior and posterior tibial, and the fibular. In a remarkable case referred to in Dr. Green's *Manuscript Notes**, the popliteal artery was a continuation of the ischiatic, the femoral having terminated at the knee joint. In this case, the internal iliac artery was much larger than the external. Either the two superior or two inferior articular branches may arise by a common trunk.

The popliteal artery divides inferiorly into the anterior and posterior tibial.

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* The reference is M. Caillard's *Thesis*, No. 307. 1833.

*The Anterior Tibial Artery,*

Smaller than the posterior, runs first horizontally forwards through the foramen between the interosseous ligament and fibula, being accompanied by a small nerve connecting the posterior to the anterior tibial; it then descends obliquely forwards, and nearly parallel to a line extending from the head of the fibula to the middle line of the ankle joint. In the rest of its course it runs on the dorsum of the foot to the interval between the metatarsal bones of the great toe and second toe; here it terminates by dividing into two branches, viz. the dorsalis pollicis and the arteria communicans. In its course down the front of the leg *its posterior surface* rests, first on a few fibres of the tibialis posticus, then on the interosseous ligament, next on the inferior extremity of the tibia, and lastly, on the astragulus, scaphoid, and internal cuneiform bone. *Its anterior surface* is covered by the anterior tibial nerve, and by the annular ligament; lower down, it is crossed by the tendon of the extensor pollicis longus; and near its termination by the internal tendon of the extensor brevis digitorum. *Its internal surface* corresponds, in the greatest part of its extent, to the tibialis anticus muscle. The *external surface* is applied superiorly to the fibres of the extensor longus digitorum, from which it is separated lower down by the fibres of the extensor pollicis. The tendon of this last muscle crosses in front of the artery, to get to its inside, and then the vessel is once more related externally to the extensor longus digitorum. In all this

course the artery is accompanied by two venæ comites, one on either side. The anterior tibial nerve is a branch of the fibular which winds round the outside of the head of the fibula, and meets its artery at the superior extremity of the extensor pollicis muscle. It is at first external to this vessel, then lies on it, and inferiorly gets a little to its inside.

*Varieties.* — The anterior tibial artery may arise above the popliteal muscle, and descend on the front of it (*Hargrave*). Or when it has arrived in the anterior region of the leg, it may descend immediately under the integument, and not between the muscles (*Pelletan*). We shall find in a future note (p. 232.), that it may be expended at the lower part of the leg. Lastly, this artery may not exist at all, and then its place is supplied by perforating branches of the posterior tibial.

*Ligature of the anterior Tibial Artery.*— If the upper part of this vessel be wounded, the wound will be our guide to the artery, and our incisions should be made in the direction of the fibres of the muscles in this situation. Its corresponding nerve lies on its outside, and on either side is a small vein. If it be the seat of aneurism, we may tie the popliteal artery in its first stage. At the front of the instep we expose the anterior tibial artery by an incision between the tendons of the extensor pollicis longus, and extensor digitorum communis. We may expect to meet in this operation, first, the internal division of the musculo-cutaneous nerve, and then the anterior tibial nerve, which either lies over, or is a little internal to the artery.

The branches of the anterior tibial artery are—

1. *The Tibial Recurrent,* which arises from the anterior tibial artery, immediately after it has passed

through the interosseous ligament. It curves upwards and inwards through the fibres of the tibialis anticus muscle, being crossed by the divisions of the tibial recurrent nerve; it spreads its branches over the anterior inferior part of the knee joint, and anastomoses with the inferior articular arteries.

2. A number of *muscular branches* are given off at various points of its course down the leg.

3. The *internal Malleolar* is given off immediately above the ankle joint; it crosses horizontally inwards behind the tendon of the tibialis anticus muscle, spreads its branches over the inside of the articulation, and anastomoses with the posterior tibial.

4. *The external Malleolar*, larger than the internal, comes off a little lower. It passes outwards behind the extensor digitorum, extensor pollicis, and peroneus anticus muscles. Its branches are distributed to the external malleolus, and to the outside of the ankle joint. It anastomoses with the tarsal, the external plantar, and the peroneal arteries.

5. The *tarsal Branch* arises as the anterior tibial is passing over the scaphoid bone; it runs outwards through the fibres of the short extensor of the toes, and passes beneath the tendons of the long extensor and peroneus anticus; it supplies the short extensor and articulations of the tarsus, and anastomoses with the metatarsal, external malleolar, external plantar, and peroneal arteries.

6. *The metatarsal Branch*, smaller than the preceding, proceeds forwards and outwards through the fibres of the short extensor, forming acurvature, the convexity

of which looks forwards, and terminates in anastomosing with the two small arteries last described, and with the external plantar. It gives many small branches to the articulations of the tarsus and to the short extensor muscle. Its most remarkable branches arise from its convexity: — they are the *three interosseal branches;* they run forwards over the muscles, filling the second third, and fourth interosseous spaces, and arrived at the bases of the phalanges, they each divide into two small branches. In this manner are produced six smaller branches that supply the toes from the internal margin of the fifth to the external margin of the second. Opposite the posterior extremities of the metatarsal bones this artery communicates with the posterior perforating branches of the external plantar; and opposite their anterior extremities it communicates with the anterior perforating arteries, which are branches of the inferior digital.

The terminating branches of the anterior tibial are the dorsalis pollicis and the ramus communicans.

7. *The Dorsalis Pollicis* advances to the interval between the first and second toes, and divides into two branches, one of which passes under the extensor tendons of the great toe, and is lost on its inner surface; whilst the other bifurcates to supply the external margin of the great toe, and the internal margin of the second toe.

8. *The Ramus Communicans* sinks between the first and second metatarsal bones, to be continuous with the terminating branch of the external plantar artery.

*The Posterior Tibial Artery*

May be exposed in the manner described in the note.* It extends from the inferior margin of the popliteus muscle to the fossa between the internal malleolus and os calcis. In this course it is directed obliquely downwards and inwards. *Posteriorly* it is crossed at its commencement by a tendinous arch connecting the origins of the soleus muscle, and is covered in the upper and middle third of the leg by the fleshy belly of the gastro-gnemius, soleus, and plantaris muscles, and more immediately by an aponeurosis (the deep tibial fascia), which is one of the expansions of the tendon of the semimembranosus muscle.

In the inferior third of the leg it descends along the internal border of the tendo Achillis, which at first covers it a little, but lower down we find it covered only by the integuments and three layers of fascia, viz. by the deep tibial fascia just described, by another sent off from the internal margin of the tendo Achillis, and by a third, which may be distinguished by its gliding loosely over the posterior surface of the tendon. *Anteriorly* this artery corresponds successively, from above downwards, to the tibialis posticus muscle, the flexor digitorum, and with the interposition of some cellular tissue to the tibia. It is accompanied by two venæ comites, one on either side. Its corresponding nerve is internal to it in the upper part of the leg; but as it descends it crosses the artery superficially, so as to

* Cut across the tendo Achillis at its upper part, and then reflect the gastro-gnemius, soleus, and plantaris muscles upwards. The deep tibial fascia may now be divided and the artery exposed.

become external to it inferiorly, and separate it from the fibular artery.

When the posterior tibial artery has arrived in the fossa, between the os calcis and internal malleolus, it is accompanied by nerves, vessels, and tendons, which lie in the following order: commencing at the internal malleolus, we find the tendon of the tibialis posticus, tendon of the flexor longus communis, small vein, artery, another small vein, nerve, and nearest the os calcis, the tendon of the flexor pollicis longus.

*Ligature of the posterior Tibial Artery.*—This vessel may be secured in the middle part of its course, either according to Mr. Guthrie's plan, by an incision through the gastro-gnemii muscles, or by the following proceeding. The patient should lie on the outside of the limb, with the knee flexed, and the ankle extended. An incision is then to be made about four inches long on the internal margin of the tibia, avoiding the saphena vein. The inner edge of the gastrognemius muscle is then to be detached from the bone, and the tibial origin of the soleus muscle divided on a director. The strong tibial fascia is now brought into view, and may be slit up on a director. The artery will then be found at the distance of about an inch from the internal edge of the tibia. The nerve lies on its outside, and there is a vein on either side.

This artery may also require to be tied where it is passing behind the internal malleolus, in consequence of a wound, to which it is particularly liable in the use of the adze; or in consequence of a wound of a large vessel in the sole of the foot. For this purpose

an incision should be made about four inches long, nearly midway between the internal malleolus, and tendo Achillis. This incision will take a curved direction, the concavity looking towards the malleolus. In this situation, we have to divide successively on the director three layers of fascia. The artery will then be exposed: on either side of it is a small vein, and behind it the posterior tibial nerve. The needle should be carried under the artery from behind forwards.

*Varieties.*—The posterior tibial artery may be deficient, and its place supplied by branches of the fibular (*Barclay*), or there may be two in the same limb, as observed by Dr. Green, in the dissecting room of Trinity College, Dublin, or it may arise higher or lower than usual (*Portal*).

The branches of the posterior tibial artery are the muscular, nutritious, and peroneal.

*The Muscular Arteries* are abundantly distributed to the heads of the gastro-gnemius and soleus muscles, and lower down to the tendons of the flexor muscles, and to the periosteum.

*The Nutritious Artery* of the tibia is the largest of the kind in the body. It first grooves the posterior surface of the tibia, and then enters the nutritious foramen, to be distributed on the medullary membrane.

*The Peroneal Artery* arises from the posterior tibial a little below the commencement of the latter, and then inclines obliquely downwards and outwards to reach the fibula, along which it descends, till it arrives near the external malleolus. Here it terminates by dividing into the anterior and posterior peroneal. In this course the peroneal artery usually pierces the superior extremity

of the tibialis posticus muscle, then lies on the interosseous ligament, being closely applied to the fibula, and covered by the flexor pollicis longus muscle. Its branches are distributed to the surrounding muscles and to the integuments and periosteum. In the inferior fourth of the leg it sends a remarkable branch horizontally inwards to anastomose with the posterior tibial. The *anterior peroneal artery* passes forwards through a foramen in the inferior extremity of the interosseous ligament, and is then found on the front of the limb beneath the tendon of the peroneus anticus. It terminates by anastomosing with the external malleolar branch of the anterior tibial.* The *posterior peroneal artery* descends behind the external malleolus, and divides on the outside of the os calcis into a number of branches which supply the periosteum, adjacent tendons and integuments, and anastomoses with the tarsal, metatarsal, and external plantar arteries.

*Operation.*—The lower part of the peroneal artery may be exposed by an incision commencing at the mid point between the tendo Achillis and external malleolus, and extending about four inches upwards and outwards towards the fibula. The fibres of the flexor pollicis longus, thus exposed, may be detached from the fibula as far as necessary, and the muscle drawn in-

* In some cases this artery is very small; in others, on the contrary, it is particularly large, and gives off the tarsal, metatarsal, dorsalis, pollicis, and communicating branches. In this latter case, the anterior tibial is small, and ceases by communicating with the anterior peroneal on the front of the ankle joint.

wards; the vessel will then be observed lying on the interosseous ligament close to the fibula. In order to reach this vessel Mr. Hey recommended sawing out a portion of the fibula.

In a case of gunshot wound, Mr. Guthrie secured it about four inches below the head of the fibula, by an incision seven inches long through the gastro-gnemius and soleus muscles. (*Med. Chir. Trans.* vol. vii. p. 344.)

Opposite the interval between the two origins of the adductor pollicis muscle, the posterior tibial terminates by dividing into the internal and external plantar artery.

*The internal Plantar Artery* is a branch of inconsiderable size; it advances above the adductor pollicis pedis; and after supplying this muscle, and the flexor pollicis brevis, terminates in branches that are distributed to the integuments of the great toe, and in anastomosis with the branches of the anterior tibial artery.

*The external Plantar Artery*, much larger than the preceding, passes obliquely forwards and outwards towards the base of the fifth metatarsal bone. In this first part of its course it nearly follows the outer margin of the flexor digitorum communis, having above it the accessory muscle, and beneath it the plantar fascia and short flexor of the toes. In the second part of its course it lies deeper, and passes forwards and inwards through a triangular space, bounded in front by the transversalis pedis, posteriorly and internally by the adductor of the great toe, and externally by the short flexor of the little toe, the

interosseous muscles being above it, and the common flexor tendons beneath it. Finally, it terminates by becoming continuous with the communicating branch of the anterior tibial (p. 228.). From this account, it follows that it describes in its entire course a curvature, the convexity of which looks forwards and outwards. Its corresponding nerve crosses to its inside, the artery being superficial at the crossing.* Its branches may be classed into three sets:—

*The superior or perforating Branches* ascend between the metatarsal bones, and anastomose with the interosseous branches of the metatarsal artery (p. 227.).

*The posterior and inferior, or muscular Branches* are distributed to the interosseous muscles and lumbricales, and to the tarso-metatarsal articulations.

*The anterior, or digital Branches* are larger than the preceding, and usually four in number. The first, or most external, supplies the outer edge of the little toe. The second, third, and fourth advance till they reach the upper surface of the transversalis pedis muscle. Here each of them sends off *an anterior perforating branch* (to communicate with the corresponding interosseous branch of the metatarsal artery), and then bifurcates. In this manner are produced six smaller branches, that supply the toes from the internal edge of the little toe to the outer edge of the second toe.

* The external plantar artery might be tied opposite the base of the fifth metatarsal bone; but in case of profuse hæmorrhage, it is much safer to tie the trunk of the posterior tibial as it passes behind the internal malleolus.

# APPENDIX.

*Varieties of Inferior Mesenteric Artery.* — The inferior mesenteric artery may be wanting (*Heischman.*) In a very remarkable case the right kidney and artery were absent; the common iliacs were united by a transverse branch, and from the left came off the inferior mesenteric artery. (*Petsch, Syll. Observ. Anat. Select.* § 76.)

*Venæ Thebesianæ.*

It was supposed by Vieussens, Thebesius, and Lancisi, that small veins opened into the left cavities of the heart. (See also, Abernethy, in the *Philosophical Transactions* for 1798.) The most accurate observers of the present day deny their existence.

*Extract from an Account of an Anomalous Distribution of the Arteries, by F. Hird, Esq.* (*Lond. Med. Gaz., Feb.* 4. 1837.)

"There being a high division of the brachial artery in the left upper extremity, the left hepatic artery arose from the abdominal artery itself, and there were two renal arteries on each side; but the irregularity to which I wish to draw attention was from the transverse portion of the arch of the aorta."

"From this portion of the aorta two branches were given off, the larger arising from that part of the artery which in the regular distribution gives origin to the arteria brachio-cephalica: the other was the left subclavian. The first of these, a thick trunk a little more than an inch in length, was directed towards the left side of the neck, and bifurcated about the middle of the trachea into the arteria brachio-cephalica and left carotid, which arteries subdivided as usual, but the situation of the former, and its continuation, the right subclavian artery, were greatly altered in

relation to the surrounding parts: they were situated much higher than usual; the subclavians passed anterior to the scalenus anticus muscle — a course that has very rarely been observed."

"There was a small triangular space formed over the front of the trachea, bounded on the right by the arteria brachio-cephalica, on the left by the left carotid; its apex being formed by the decussation of these arteries, and its base by the thyroid gland."

"The vertebral artery was larger than natural, remarkably superficial, and ascended as high as the second cervical vertebra before entering the foramina in their transverse processes."

"The phrenic nerve descended along the outer margin of the scalenus anticus muscle, crossed the subclavian artery at a right angle, lying immediately upon it, still situated at the external border of the muscle."

*On the different Plans of Tying Arteries for Aneurism.*

In cases of aneurism, we apply a ligature either on the plan of Hunter, Brasdor, or Wardrop.

*Hunter's* plan is so generally practised, and so well understood, that we may dispose of it in the fewest words possible. It is sufficient to say that he applied a ligature on the cardiac side of the aneurism, with the view of obstructing the circulation in the sac, and rendering it impervious.

*Brasdor's* plan was intended to provide for the cure of an aneurism which was so situated that it would be impossible to apply a ligature round the affected vessel on the cardiac side of the tumour. In such case he proposed to secure it on its distal or capillary side. Dessault mentioned Brasdor's plan in his public lectures; and stated as his opinion, that it was worthy of trial in those cases in which Hunter's operation was impracticable. Neither of these distinguished surgeons, however, performed the operation themselves. It was first performed by their cotemporary Deschamps; and first with success by Wardrop, in a case of carotid aneurism. Those who recommended and adopted Brasdor's plan, did so on the principle that it completely obstructed the circulation in the sac; and they supposed that if a branch was given off between the tumour and the ligature, the operation must necessarily fail.

*Wardrop* saw clearly the fallacy of this conclusion. He had observed that aneurisms got well spontaneously, without the complete interruption of the circulation in the sac; and that in some cases of popliteal aneurism, in which Mr. Hunter's operation had been performed, the complete stoppage of the blood within the tumour was not required. These considerations induced him to believe that an aneurism might be cured by placing a ligature *on one of the branches* of the diseased artery, instead of the trunk of the vessel itself; and that, in this manner, many cases might be successfully treated, in which neither Hunter's nor Brasdor's operation could be performed. This operation was first performed by Wardrop himself, and afterwards by Evans, Mott, Dupuytren, Home, Morrison, Laugier, Fearn, Scott, and Key. In some cases the success was partial; and in others, as in Evans's case, complete. (See the *Cyclopædia of Surgery*, article ANEURISM.)

*Ophthalmic Artery.* (p. 58.)

In order to expose the parts contained in the orbit, the brain should be removed from the cranium in the usual way; two vertical incisions should next be made, commencing, one at the external and the other at the internal angular process of the frontal bone. If these be directed so as to meet posteriorly in the spheroidal fissure, they will be found to include between them almost the whole of the roof of the orbit, which may accordingly be readily detached with the hammer. The soft parts may then be dissected.

THE END

## *The Vertebral Artery in Part of its Course, from a Dissection by Dr. Flood.*

1. The Sub-occipital Nerve, presenting a small oblong Ganglion. 2. The Transverse Process of the Atlas. 3 & 4. The Ganglions of the Second and Third Cervical Nerves. 5. The Pharynx. 6. The Carotid Artery. 7. The Theca Vertebralis, divided longitudinally. 8. The Ligamentum Dentatum. 9. The Vertebral Artery, passing forwards between the first and second tooth of the Ligamentum Dentatum. 10. The Pneumo-gastric and Glosso-pharyngeal Nerves, meeting the Spinal Accessary at the Foramen Lacerum. 11. The Roots of the Ninth or Hypo-glossal. 12. The Inferior Artery of the Cerebellum, running backwards between the Spinal Accessary and Pneumo-gastric Nerve. 13. The Basilar Artery, separating the Sixth Nerve of the Right side from that of the Left side. 14. The Spinal Accessary Nerve of the Right side.

*The Ligamentum Dentatum* (8) is a fibrous band, extending along the side of the spinal marrow from the occipital bone to the second lumbar vertebra. In this course, it separates the anterior Root (3) from the posterior Root (4) of the Spinal Nerves: its external margin is dentated, presenting a series of Teeth or Processes. The first tooth is inserted into the occipital bone, between the Ninth Nerve (11) and Vertebral Artery (9).

*The Spinal Accessary Nerve* (14) ascends between the Ligamentum Dentatum and posterior roots of the nerves, and joins the Glosso-pharyngeal and Pneumo-gastric Nerves, from which it had been separated farther back by the inferior Artery of the Cerebellum (12).

*The Vertebral Artery* (9) ascends through the foramina in the transverse processes of all the cervical vertebræ, except the 7th. In this course it is crossed by the Cervical Nerves (3 and 4), which pass outwards behind it. In passing from the second Cervical Vertebra to the Atlas, it has to form a considerable curve, the convexity of which looks downwards and outwards. It then runs horizontally inwards, forming a curvature, the concavity of which looks forwards, and embraces the condyle of the occipital bone. While forming this latter curve, it rests on the Atlas, with the interposition of the Sub-occipital Nerve, as seen on the right side, where the vessel is raised by a hook from its natural situation. The Vertebral Artery then pierces the posterior vaginal ligament and dura mater, separates the first and second tooth of the dentated ligament, and runs upwards and inwards, in front of the first tooth (while the Spinal Accessary Nerve runs upwards and outwards behind it); it then continues to ascend in front of the eighth and ninth nerves and medulla oblongata, to join that of the opposite side, and form the Basilar Artery (13).

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*** Dr. Flood has now settled permanently in London; and continues, as heretofore, to prepare Pupils for the various Colleges, at his residence, 37. Bernard Street, Russell Square.